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AN INTERESTING ELECTRIC COAL AND ASH HANDLING PLANT

UP-TO-DATE ELECTRICALLY-DRIVEN EQUIPMENT

BY FRANK C. PERKINS

ONE OF THE GREATEST labor saving devices of the power plant is shown in the accompanying illustrations which give an excellent idea of how electric power is utilized at the Cleveland Kodak Park Plant.

It may be stated that the storage bins are located in front and above the boilers as indicated in Fig. 1, which also shows the pit uncovered giving a clear view of the running parts of the conveyor. The coal is fed direct by gravity through self locking dust tight valves and spouts to the stoker magazines.

Provision is made for crushing 75 tons of bituminous coal per car and delivering to the storage bins as noted in Fig. 2. Figure 3 shows the steel track hopper located in a pit under the railroad track, and Figs. 4 and 5 indicate the arrangement for driving the conveyor with a 15-hp. motor, direct connected by steel cut gears.

FIG. 1.—MURPHY STOKERS AND COAL HANDLING MACHINERY IN THE BOILER ROOM

Ash Conveyor

IT will be seen that in a concrete pit in front of the boiler a conveyor of the Bartlett & Snow overlapping type carries the ash as it is scraped or shoveled into the pans, and discharges it into an elevator located at one end of the boiler room. The elevator in turn discharges into a storage bin whence it is drawn into a railroad car.

It may be stated that the steel track hopper located

in the pit under the railroad track is 12 ft. wide by 16 ft. long at the top, and large enough to receive coal from the largest hopper-bottom railroad car, and deliver by gravity directly to a steel apron feeder located in the pit and under the hopper. The hopper at the discharge end is provided with a special valve for closing the opening from 2½ by 3 ft. to about ½ that size, when fine coal is handled.

Carrier Belt and Crusher

FOR a distance of 22 ft. between the hopper opening and the crusher an overlapping endless, steel belt carrier is provided 36 in. wide, for regulating the quantity of coal from the hopper to the crusher. The quantity of coal delivered may be varied by changing

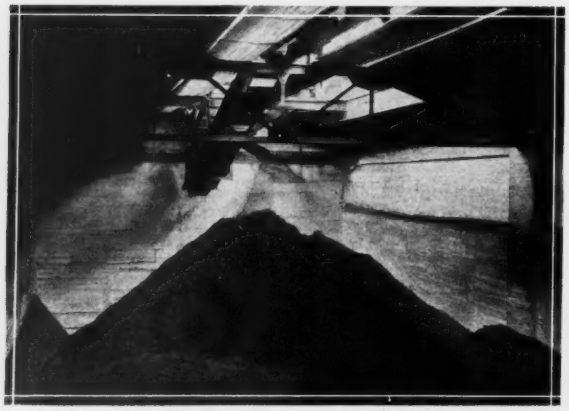


FIG. 2.—DELIVERY TO STORAGE BINS

the speed of the steel belt. The steel belt is composed of 2 strands or lines of 6-in. pitch drop-forged roller chain, and suspended between the 2 chains are steel plates with ends curved, one overlapping the other

FIG. 4.—COAL CONVEYOR RUN AND GEARED MOTOR DRIVE

shingle fashion, and with sides 9 in. high, forming a continuous moving trough carried on rollers.

Between the feeder belt and the crusher is located a hopper having 2 outlets in the bottom, and so arranged that 1 valve may close 1 outlet and open the other. When large coal is handled, the large opening is opened and the small one closed, and coal through the large opening is discharged to the crusher where it is broken to the proper size before it is delivered to the combination elevator and conveyor. When fine coal is handled the small opening is open and the large one closed, and coal is spouted around the crusher direct to the combination elevator and conveyor. In this way the crusher is used only when large coal is handled.

The 2-roll crusher has rolls 26 in. diameter and 26 in. face and is built up of hexagonal segments bolted to spiders or hubs on either end. Should some hard foreign substance accidentally pass through the crusher, damaging 1 or more of the segments, it is necessary to take out only the damaged segment, and not remove the entire roll. If it were a solid roll the entire roll would be lost. A 40-hp. motor, direct-connected, drives the rolls 150 r.p.m.

A combination elevator and conveyor is provided for conveying from the crusher, elevating and again conveying over and discharging into the storage bin.

FIG. 3.—TRACK HOPPERS. COAL DELIVERY BELOW; ASH LOADING FROM ABOVE

It has 2 lines of 12-in. pitch drop-forged roller chain, and between the 2 strands of chain are suspended V-shaped buckets, 24 in. on centers, connected with forged-steel swivel connections. The buckets may be seen in Fig. 4. When on the horizontal the V-shaped buckets are in a position partly to carry and partly to scrape the coal in a trough, and when in the vertical to carry the same as an elevator. The trough is arranged to engage with the buckets to discharge or receive the coal without spilling. In the trough over the storage bins are openings on 10 ft. centers, provided with valves operated with rack and pinion and handwheel.

Feed to the Boilers

COAL is fed by gravity through dust tight valves and down spouts, from the bins to the stoker magazines in front of the boilers, as shown in Fig. 1, the valves being of the undercut double locking type. They lock automatically in both open and closed positions, and no power can either close or open them unless applied on the handwheel or chain. Valves are in a dust-tight casing, and the shaft operating the valves

passes through the casing in a stuffing box. The spouts have bell-shaped discharge ends to spread the coal in the magazine, and are bolted both to the valve casing and magazine dust tight, making the boiler room as free from dirt and dust as is possible to secure.

Ash Handling

IN a concrete pit or tunnel passing in front of the boiler is a pan conveyor carrying ash to a vertical elevator at 1 end of the building. The pans are malleable iron of the overlapping type, forming a continuous moving trough to prevent the pans from being overloaded and the ash from falling onto the chain or into the pit. The capping or cover over the conveyor where the ash is shoveled into the pan hopper is cast open and the discharge end brought together to one half the width of the pan, leaving a space in the pan that may be filled by the conveyor itself when dragging the ash beyond the opening in the hopper. It will be seen in Fig. 1, that ash cannot pass around the pans

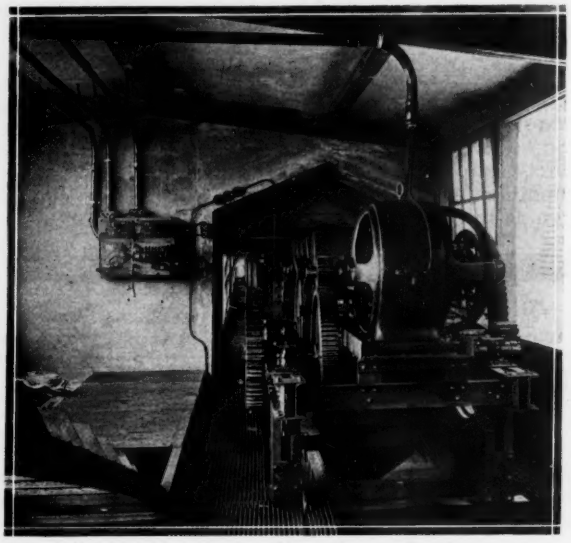


FIG. 5.—ASH CONVEYOR TUNNEL AND MOTOR CONTROL

onto the chain or into the pit. Pans are suspended between 2 strands of drop-forged roller chain. The forgings are the same as for the coal conveyor chain, but the rollers are on the outside of the chain and not in the chain, as is the case in the coal conveyor. The axles to which the pans are connected also form the chain pins, and with the shafts passing through the chain give admirable conditions for connecting large diameter rollers.

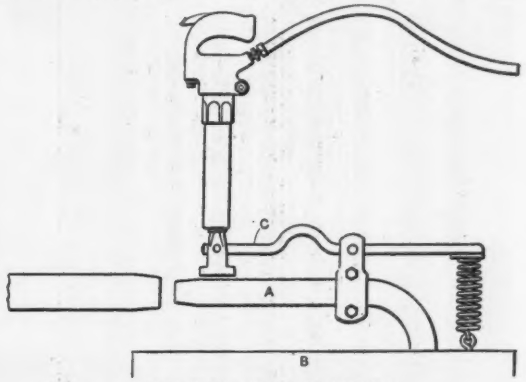
These are 6-in. diameter, of self-oiling type, having chambers holding 1 pint of oil cast on the inside. Rollers are charged through an automatic opening and closing spring valve, and lubrication is applied continuously to the journals from the inside; should dirt get on the journal, it is carried to the outer surface by the oil, as the oil applied on the inside must work outward. A motor, direct connected by cut steel gears, drives the conveyor 25 ft. a minute from the end near the elevator.

It may be stated that under operating conditions the pit is covered with a checkered cast-iron covering, except that in front of each ash pit is provided a section 30 in. long having 2½ in. square holes through which ash is delivered to the conveyor. At the end of the conveyor a vertical elevator receives and discharges the ash into a storage bin.

It may be stated that the elevator is a single strand heavy malleable chain, and connected thereto at 16-in. centers are malleable buckets. The elevator is enclosed in a dust-tight casing of heavy steel plates, and a motor, direct connected with cut steel gears, drives the elevator at the discharge end. It is of interest to note in Fig. 3, that the ash bin is located directly over the coal hopper, as the spout is shown connected to the bottom of the bin.

PNEUMATIC FLUE WELDER

AN INEXPENSIVE flue-welding device that was designed to handle a large repair job that came in unexpectedly is shown in the accompanying illustration. It consists of a mandrel A, which is attached to a cast-iron block B, and a pneumatic hammer (equipped with a swage), which is mounted on a lever C. As the illustration shows, this arm is fulcrumed to a bracket on the mandrel and is spring supported. The ends of the long pieces were first scarfed by lowering the back end of the tube until it was about 6 in. below the level of the mandrel. This gave a taper of approximately ¼ in. to the inch. After all the long pieces were scarfed, short pieces about 8



TOOL FOR FLUE WELDING

in. long were placed in the furnace and heated on one end so that they could be drawn to a feather edge. This was also done under the pneumatic hammer.

After all the flues were scarfed and the short ends made ready for welding, the horse upon which the outer ends of the flues had rested, was raised to bring the work level with the mandrel. All short pieces were then put on the flues while hot so they would shrink tightly in place, thus insuring a good clean weld by preventing any dirt from getting between the surfaces to be welded. After all flues were treated in this way the furnace was cleaned, and the welding done at a speed which would make many of the costly flue-welding machines hustle to keep up with.

T. O. Martin.—Machinery.

RADIUM HAS BEEN SHOWN by Sir William Ramsay to have a life forever spite of the fact that ⅔ its energy is transferred to the gas that it gives off. The amount emitted is proportional to the mass of radium at any time so that the division will go on indefinitely. It will, however, be about half used up in 1,750 yr. Condensed to liquid form, the gas from radium has a purplish light but is transparent. It solidifies at —60 deg. Cent. and then has a brilliant light like a small electric arc.

"WORK WELL DONE to-day and to-morrow, promises us better for the future."

THE FUEL ECONOMIZER

OPERATION AND REPAIRS

By Carl S. Dow

JUST AS A BOILER is operated by supplying it with water and heat, so an economizer is operated by keeping it filled with water and maintaining a flow of hot gas between and among the tubes. In a broad sense, no directions for operating any machine or apparatus are necessary to the man having a conception of the purpose and design, but with an economizer good results are most easily obtained when the attendant knows what parts require regulation and what ones are most liable to need repairs.

The reserve flue damper or by-pass damper is kept open while raising steam. To pass the gas through

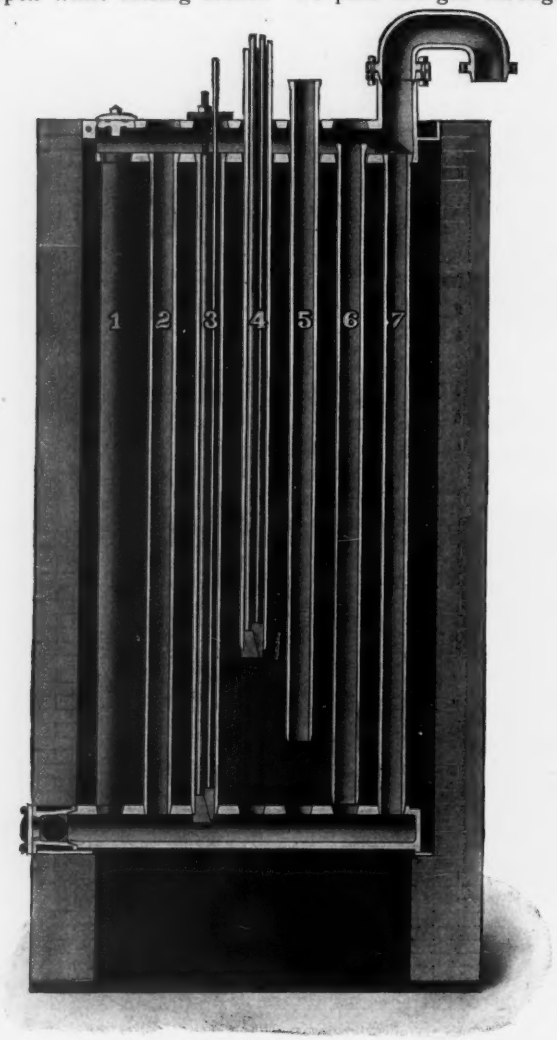


FIG. 2.—METHOD OF REMOVING PIPES FROM STURTEVANT ECONOMIZER

the economizer, this damper must be closed else the gas will go directly to the chimney but it should not be closed until the scrapers are started. Dampers in the inlet and outlet flues of the economizer must be open to allow the gas to pass around the tubes. The main damper at the outlet end of the economizer is the one to be used in regulating the draft. The boiler dampers are for use only when a boiler is cut out.

By means of a pump the feed water is forced through the economizer, and becoming heated leaves by way of a pipe connected to the headers and enters the boilers against the pressure carried. It is evident that the valve between the economizer and the boilers, called the outlet valve, must never be closed while steam is being raised or while the economizer and boilers are in operation, for through this valve passes all the feed water. Also the inlet valve which is in the feed pipe between the pump and the economizer should not be closed unless the economizer is to be shut down. It should be understood that the pump is so located that the water enters the cool end, or outlet end, and leaves at the hot end so that it is raised to the maximum temperature.

In addition to the inlet and outlet valves, every economizer should have a relief valve set to open at a pressure slightly greater than the working pressure on the boilers; also a safety valve, which like the boiler safety valve, should be tried daily and kept in good condition. A blow-out valve having the same function as the valve of the same name for the boiler pro-

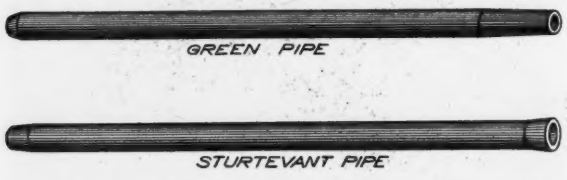


FIG. 1.—GREEN AND STURTEVANT ECONOMIZER PIPES

vides for blowing out the sludge which forms when soda ash and other scale-forming preventives are used regularly.

It is a mistake to allow the scrapers to be idle while hot gas is passing through the economizer, for the gas must deposit soot and dust. The scrapers should be at work constantly, for the amount of power required for driving them is so small that there is no appreciable saving effected by stopping them. If the scrapers stick, causing the chains to slip on the sheaves at the ends of the stroke, they may be worked by hand until they run freely if the set screw fastening the chain pulley to the worm wheel is removed. If from the slipping of a chain on its sheave, the scrapers get out of adjustment, they may be shifted by lifting up the chains and slipping them on the pulleys or by loosening the set screw and moving the sheave to the desired position.

To clean the interior of the pipes and the bottom headers, the economizer is cut out of service by bypassing the gas to the stack and feeding the water direct to the boilers. After cooling, the pipes can readily be flushed out if the deposit is soft—if hard or if it adheres strongly, it may be removed by a good boiler tube cleaner.

The soot chamber beneath the economizer should be cleaned out frequently. If allowed to collect, the soot is liable to impair the effectiveness of the heating surfaces by getting into the spaces around the bottom headers and wall boxes.

The scrapers are supposed to keep the tubes free from soot, but should it accumulate in an economizer so walled in that special hand cleaning is inconvenient or impossible, it may be burned off by feeding the water direct to the boilers and emptying the economizer. The burning off of soot should be done while the scrapers are running. This operation should not be attempted by an inexperienced person.

If for any reason the water should get too low, the economizer should be cut out and allowed to cool down, the cooling being hastened by opening all doors of the economizer chamber. The safety valve should remain untouched until the tubes are cool.

Repairs

THE fuel economizer is not a delicate apparatus nor one requiring much in the way of repairs. Nevertheless repairs are sometimes necessary even though the manufacturers make it as durable as possible because the saving depends almost as much upon the freedom from repair expense as upon saving of fuel. Because it is largely of cast iron, the few repairs are generally due to breakage, which means that the defective part is replaced by a sound casting. The procedure of taking out the broken casting and putting in the new one depends upon the make of economizer, because in designing the apparatus the matter of repairs has always been an important element controlling the shape of the details.

Because of the many parts the replacing of a defective casting often means the breaking and making of many joints for every pipe is joined to a header at the top and bottom and each header is joined to a wall box at the bottom and a manifold at the top.

The shape of the pipe ends has much to do with the making and breaking of joints—more than a casual observer would think possible. There are now on the market 2 principal types or makes: the Green and the Sturtevant. The pipe of the former has machined tapered ends, the tapers extending in opposite directions, while in the latter type the pipe ends have tapers extending in the same direction, that is, they are parallel.

Replacing a Broken Pipe

WITH the Sturtevant, a broken pipe is replaced as follows: the cap in the top header directly over the damaged pipe is first knocked in and a draw bar and wedge lowered into the pipe. With the shoulder engaging the lower end and kept in place by the wedge, the nut is turned until the friction joints in the headers are released. The pipe is then drawn up, taken out of the economizer, and a new one put in. The new pipe which is exactly like the old one, because the machined tapers are made to gage, is made tight by a few light blows with a hammer. No packing or rusting is necessary for the joint is a metal taper machined on the pipe and in the headers. The defective pipe is readily removed because the upper end is of greater diameter than the lower end, and the holes in the top header are larger than the lower end of the pipe. In fact all the pipe except the top taper slips through the top header with ease.

In case of a broken or cracked bottom header, all the pipes of that row or section must be removed. The caps of the top header are first knocked in and the pipes removed by following the method described. The bottom header is now disconnected from the wall box and allowed to drop into the soot pit. In this make of economizer the bottom header will drop into the soot pit without disturbing the brick setting, for the side wall is outside of the header. The new bottom header is then put in position, bolted to the wall box, and after both top and bottom headers are shored up, the pipes are returned and driven in place.

A damaged top header is replaced without disturbing the bottom header. The caps in the top header are knocked in and the pipes of that row or section removed as before. After disconnecting from the top manifold, the header is removed and the new one put in place. Both headers are then shored up and the pipes put back.

Repairing a Green Economizer

THE general method of repairing a Sturtevant economizer is followed with the Green, the differences being due to differences in details of construction. To get at the interior of the headers for inspecting, cleaning, or repairing a Green economizer, a hand hole is located in the top header over each tube. For low and moderate pressures the external lids are held in place

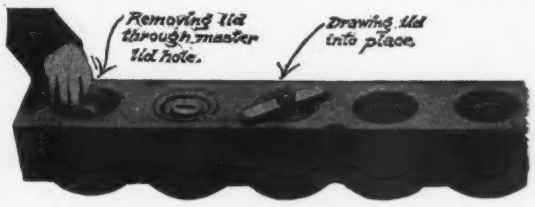


FIG. 3.—IMPROVED TOP HEADER FOR GREEN ECONOMIZER

by bolts and yokes, but for higher pressures a cap or lid with the taper extending in the opposite direction is preferable, for with the large diameter inside, the internal pressure maintains the cap in position, and the greater the pressure the tighter the joint. These lids are drawn into place with a tee bolt. The inner diameter being larger than the hole in the header, the lid cannot pass through, a condition which makes nec-

FIG. 4.—TOP HEADER OF GREEN ECONOMIZER SHOWING TAPER JOINTS

essary a larger or master lid hole at the end of each header. All lids may be passed along and removed through this master lid hole.

The pipes of the Green economizer, as has been stated, have a top taper just like the bottom taper. A glance at the illustration of the lids shows that a pipe cannot be drawn through the hole, therefore in replacing a damaged pipe it is removed by cutting or splitting the end with a chisel. In removing a broken pipe accessible from the outside, such as when a section is out of position or easily reached from a flue, both ends may be cut and the pipe removed without using the draw out rod; when pipes are not thus accessible the lid or cap is taken off and after splitting the upper end with a chisel it is removed by means of the draw out rod as explained.

The repair tube of the Sturtevant is exactly like the original, as has been said; but the repair tube of the Green is essentially different—it is smaller at the top for it must pass through the hole in the top header. Having removed the old pipe, the repair pipe is passed through the lid hole and driven into the correspond-

ing hole in the bottom header; the driving must cease when the blow becomes solid, else the header may split.

The lower end of the pipe makes a tight joint of itself for it is a taper metal fit, but at the top end the space must be filled and calked with cast-iron borings and sal ammoniac, which makes a rust joint. As several hours are required for rust joints to set, the economizer so repaired should remain out of commission for a few hours.

If a header is to be replaced, or if a pipe and a header, the new pipe can be like the original, that is, with full sized top end, for all the ends must be taken out of the top header in order that the new one may be put on. To place the new header in position put whatever new pipes are required in the sockets in the bottom header and draw the new top header onto the ends of the pipes by means of bolts.

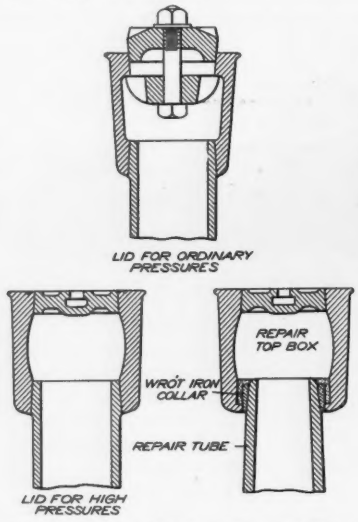


FIG. 5.—FORMS OF LIDS, BOXES AND TUBE ENDS FOR GREEN ECONOMIZER

It may be that there is not time to replace a pipe, the load may be such that the economizer cannot be spared so long at the time the damage is discovered. In such a case, the pipe may be stopped off temporarily by plugs placed in each end and held in position by a piece of wrought-iron pipe.

Or if a header is damaged, the whole section or row may be cut out by removing the bolts which hold the flanges of the header to the top branch pipe or manifold and to the bottom branch pipe or wall box, and after lowering the section about a quarter of an inch placing a thin metal plate and a rubber joint ring between the flange at both top and bottom. After replacing and tightening the bolts in the flanges, the water may then be turned into the economizer, for it can flow through the other sections. Repairs to the section should be made soon for there being no water in the section it may become damaged.

FOR COATING MASONRY with a wax varnish finish, carefully heat 150 parts white wax in a boiler by means of steam, so that it does not become brown, until it is melted, and pour in 2,250 parts turpentine oil and allow to cool. When cold, add 4,500 parts white Dammar varnish. If the varnish is too bright when dry, increase the quantity of wax. First prime the wall with linseed oil, then apply 4 coats of paint; smooth, and finally apply the coating of wax varnish.

BOILER TYPES AND PROPORTIONS

BY PERCIVAL R. MOSES

IN AN article in The Isolated Plant are discussed the characteristics of different types of boilers, and the situations where each is best used. The following are abstracts from the article as it appeared.

Horizontal Return Tubular Boilers

NUMBERS of tests show that in its own field the horizontal return tubular boiler is as efficient as any type, and has certain advantages. This field is in plants where pressures of 125 lb. or less are carried and where the capacity of each unit is 200 hp. or less.

The reasons for the superiority of this type of boiler under these conditions are, in the opinion of the writer:

First, there is a large body of water directly over the fire offering a large heat-absorbing capacity exactly where it is required.

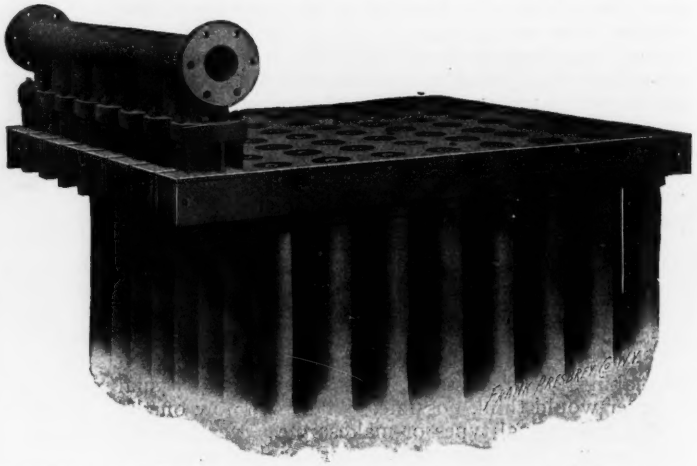


FIG. 6.—GROUP OF GREEN FUEL ECONOMIZER SECTIONS

Second, for a given heat-absorbing capacity it is possible to get a greater amount of grate surface without going to an excessive depth.

Third, because of the possibility of getting inside the boiler below the tubes through the manhole it is possible to maintain the horizontal return tubular boiler in a high average condition of efficiency. Perhaps, it would be more nearly correct to say that it is probable that the efficiency will be maintained in a high state.

Fourth, the cost of horizontal return tubular boilers is low.

The Water Tube Boiler

IN plants where the units are over 200 hp. and the pressures above 125 lb., this type of boiler reigns supreme. As soon as pressures and sizes go above these limits, the thickness of metal required for safety in boilers of the horizontal return tubular type becomes excessive and prevents ready transfer of heat. For 150 to 250 lb. a thickness of 1 in. or more of shell would be necessary, and it would be impossible to make a thoroughly safe boiler with this thickness of metal.

It is, therefore, necessary to go to a divided surface in which water is circulated through tubes, the fire going outside the tubes. As these tubes are only 4 in. in diameter, the thickness can be kept small and a rapid rate of heat transmission maintained.

Marine Type of Boiler

THE marine type of boiler, as its name indicates, was originally designed for marine service because of limited space conditions and the necessity of having the boilers entirely self-contained. The objection to the marine type of boiler for stationary use is, that the grates being confined by the sides of the boiler it is necessary to make them extra long in order to get the required grate surface. The advantage lies in the absence of brick work and in the fact that all radiation from the fire is absorbed by the water of the boiler.

The fact that the fire is entirely surrounded by water, except at the front and rear ends, frequently gives rise to trouble from contraction and expansion, and the cost of repairing and maintaining the marine type of boiler is usually high.

Safety

SO long as the thickness of metal is not carried above 9/16 in., and the riveting is done in a manner to insure equal distribution of strain, the horizontal return-tubular boiler is safe in my estimation. This opinion is also held by the chief inspector of one of the largest of the insurance companies.

In all such boilers properly designed there is a factor of safety of at least 5, i. e. the bursting pressure is 5 times the working pressure.

Safety valves are provided which blow when the pressure exceeds the working pressure by 10 per cent, and fusible plugs are provided which burn out when the water gets below the tops of the tubes.

It is to be remembered that in the water-tube type of boiler the steam drum is 36 to 42 in. in diameter and 12 to 18 ft. long, so that there is nearly as great liability to explosion as with the horizontal tubular type. In the latter type the tubes act as stays and an explosion is impossible unless the boiler is allowed to grow weak by continued neglect and age. Many return-tubular boilers are operating after 30 yr. service, the only things done during that time having been the renewal of the brickwork and, perhaps, one retubing.

There is no reason why any boiler should explode if properly cared for and inspected. The type which is easiest inspected and kept clean is least liable to explode.

Grate Surface Required

IT is of no use to put in heat absorbing capacity equal to 300 hp. and supply only heat producing capacity of 150 hp. But an excess of heat producing capacity may be useful even if the heat absorbing capacity is not sufficient.

The heat producing part of the boiler is the grate surface, taken in connection with the fire box, combustion chamber and chimney. We hear a great deal about ratio of heat surface and grate surface, and in the use of the phrase the essential fact is forgotten. It is this: Each different quality of coal requires a different quantity of grate surface, and the greater the draft intensity the less quantity of grate surface will be required for the same quality of fuel. A rate of combustion of between 25 and 40 lb. per square foot of soft coal is not unusual, while with the smaller sizes of anthracite—such as Nos. 2 and 3 buckwheat—12 to 15 lb. per square foot per hour is a maximum without forced draft. It is evident that a grate surface suitable for soft coal would hardly be half big enough for the smaller sizes of anthracite. On the other hand, in the combustion of fuel, soft coal with its long flame requires a much larger combustion chamber and a greater difference between the grate surface and the heat surface than the hard coal, which burns with a short flame.

The safe way to decide the quantity of grate surface required is to determine upon the lowest grade of fuel that will be burned in the plant in question, then the quantity of pounds per hour that can safely be burned per square foot of this fuel, and to fix the grate surface accordingly. Generally speaking, for small sizes of anthracite there should be at least 1 sq. ft. of grate surface to every 3 hp. of boiler capacity, with natural draft and the ordinary height of chimney obtaining in factories and other manufacturing establishments. If soft coal is to be used exclusively, 1 sq. ft. of grate surface to every 5 hp. is sufficient, but for smokeless operation this should be increased.

Design of Boiler Setting

DESIGN of the boiler setting should also vary for different service. If high steam pressures are to be carried, it is evident that the gases must leave the boiler at a higher temperature because of the higher temperature of the steam than would be the case with low steam pressures. Hence, in the installation of heating boilers of the horizontal return-tubular type it is often advisable to allow the gases to make a return trip over the top of the boiler, i. e., to pass first under the boiler, back through the tubes and then back again over the top of the boiler through a return flue, thus reducing the temperature of the gases as much as possible. Similarly, the baffling of a water-tube boiler should be different where a 150-lb. pressure is to be carried from what it would be for 75 or for 250 lb.

High steam pressure means comparatively short tubes of large diameter, and low pressure, long tubes of small diameter. Also, a low grade of fuel and a low maximum temperature call for a larger amount of heating surface than high-grade fuel and high furnace temperature.

Domes on Tubular Boilers

DOMES on this type of boiler are advisable only for small boilers where it is difficult to get space between the tubes and the shell for the steam. Boilers 66 in. or larger in diameter do not require domes, and the dome is an element of weakness and has increased radiating surface. A dry pipe or a U tube inside the boiler accomplishes the same result at a less cost.

Details of Construction

AS between charcoal iron and steel tubes, my experience has been that the steel tubes pit and corrode more rapidly than those of iron. It is the consensus of opinion that iron tubes are the best.

The old lap method for joints is still in use for low-pressure boilers, but for high pressures the butt strap is much to be preferred, as an equal strain is secured on both sheets and a much greater efficiency of joint is obtained. There is a difference of opinion as to whether it is better to turn over the ends of the tubes where they come through the head complete or just to flare them. I prefer the flaring, as there is less tendency to crack and it is easier to expand the tubes when necessary.

Occasionally a contractor is found who does not wish to put a manhole under the tubes as well as one above them in the shell. In all cases, there should be a manhole under the tubes, as without such manhole it is impossible properly to clean the boiler and inspect it inside. There should also be a handhole in the rear end under the tubes. There is also a difference of opinion about the use of a curtain sheet, i. e., extension of the boiler forward over the front of the tubes, at the bottom, so that by no chance can the fire short-circuit

to the flue. I have found the curtain sheet advisable, as where it is omitted the expansion of the boiler tends to depress the brickwork, and in a short time fire is found coming directly from the furnace into the uptake from the boiler. This cannot possibly happen with a curtain sheet, and the expense of this sheet is nominal.

In bracing a boiler, the main thing is to have the braces tight and the rivets tight, and it is my practice to have 2 additional braces put through from end to end of the boiler, below the tubes on each side of the manhole, to act as stays for this part of the heads.

For both horizontal return-tubular and water-tube boilers, the most perfect method of suspending the boilers is to support them on iron work entirely independent of the brickwork. With horizontal return-tubular boilers, however, if the supporting lugs are made long enough to reach to the outside walls and not to bring the weight on the inside lining, supporting the boiler on the brick walls is entirely satisfactory and usually less expensive than the iron support. Where the building conditions demand that the walls be made thin, so that the weight of the boiler would come on the lining, the iron support is the better. Care must be taken with horizontal return-tubular boilers, if the boilers are hung, that expansion takes place towards the rear so that the front will not be pushed out.

OPERATION OF BOILER PLANTS

DETECTING AND PREVENTING FURNACE LOSSES

TESTING a boiler plant frequently or continuously to ascertain the amount of coal and water used and other operating conditions, will give the actual performance of the plant and its variation, but will not show the why of variations nor indicate where improvement may be made. To find out these things it is necessary to dig deep into the details, and the instruments available are the thermometer or pyrometer, the draft gage and the gas analysis apparatus. Recording devices for temperature, draft and carbon dioxide percentage give a tab on the running of the plant, but to really attain the best conditions and find out what changes give improvement in operation requires the use of indicating instruments which can be applied at different points in the furnace and will give instantaneous indications of the furnace conditions.

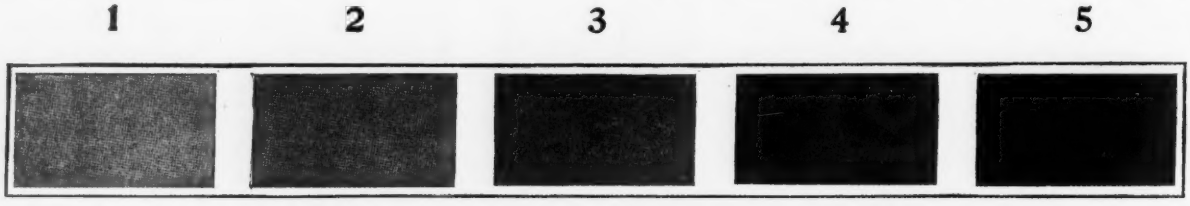


FIG. 1.—CHART USED IN DETERMINING THE DENSITY OF SMOKE.

Air Leaks

UNLESS it is watched carefully, air leakage becomes a serious source of loss. Joseph N. Hays, in his book How to Build Up Furnace Efficiency, estimates that this loss runs from 3 to 5 per cent of the fuel in average cases. The method of determining air leakage is by drawing samples of the gases from the furnace and from the breeching simultaneously and testing these for percentage of carbon dioxide. If there is no air leakage the percentage of CO_2 ought to be greater in the breeching than in the furnace, or at least as great. If air leaks in between the furnace and the breeching the CO_2 percentage will drop as a consequence.

With air leakage determined it is necessary to find out where, and this is accomplished by drawing samples of the gas from each pass through the boiler, analyzing for CO_2 and comparing results. Evidently, if no air is admitted except through the firebox, the percentage of CO_2 ought to go on increasing up to the time that the combustion is completed and from that point should remain constant. At any place where the CO_2 begins to grow less there must be air leakage to explain this result. Of course, the leakage must be remedied by plugging up cracks, making sure that all mortar joints are tight, and frequently a coat of sizing made by disolving glue in hot water will be effectual in stopping leakage of air through the pores of the brick. Mr. Hayes advocates also, to make doubly sure, the application of an insulation consisting of 2 in. of asbestos plaster covered with canvas and painted. With these precautions taken, air leakage ought to be stopped.

The question as to how much air is allowable is answered by the statement that "That furnace is the most efficient which completely consumes the combustible with the least surplus of air."

The air space through the grates should be such that 0.2 to 0.3 in. of draft will burn the necessary fuel properly. As to regulating the draft, the least that can be employed and carry the load, the best for the coal pile, provided always that sufficient air is drawn in to burn the fuel. The draft which gives the largest percentage of CO_2 in the chimney with practically no CO is best for your plant.

Draft

DRAFT should be regulated carefully, as a small fraction of an inch difference in draft may make a large difference in fuel consumption. For ordinary testing, the U tube draft gage is good enough. This is simply a piece of glass tubing bent in the shape of a U, connected at one end to the draft nozzle by means of a rubber tube, and left open at the other end. The U is about half filled with water and the difference in level in the legs measures the strength of the draft.

By punching in and making a draft connection at various points along the path of the gases the proportion of the draft used up in each pass can be determined. Of course, the greatest resistance is through the fuel bed, but leaving this out there should be a reasonably uniform drop in the draft pressure from the firebox to the breeching. If any part of the passage shows more than a normal amount of draft the cause of this should be sought out and removed if possible.

As to regulating the draft, the damper should be used rather than ashpit doors, because regulating by the doors tends to increase whatever air leakage may exist. Careful attention should be given to regulating the air supply above the fire as well as that through the ashpit. When this is just right gases drawn from the far end of the combustion chamber will show a maximum percentage of CO_2 and no CO.

Temperature

TEMPERATURE tests should be made in the firebox, the combustion chamber and the base of the stack. To get the best combustion the volatile gases should rise to kindling temperature as soon as possible after leaving the fuel bed, and a low firebox temperature means that combustion will be delayed possibly to the point where it is not completed in the combustion chamber. A condition where temperature in the combustion chamber does not hold up throughout its entire length is bad, for the gases want to get to the heating surfaces of the boiler at as high temperature as possible. Of course, extra temperature in the chimney base shows heat going to waste and means either too great forcing of the boiler or late burning of the gases. The drop in temperature should be between the point where the gases strike the heating surface and the breeching.

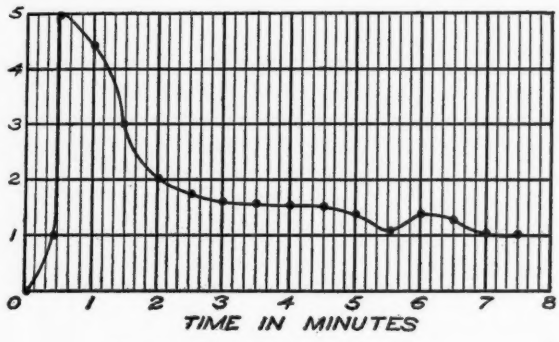


FIG. 2.—TYPICAL SMOKE RECORD

Grate Area

IN regard to the grate, this is too large if the fuel bed cannot be increased without causing the safety valve to blow. Grate surface can be cut down by putting a lining of firebrick inside the firebox to cut off part of the grate. If, on the other hand, the boiler setting is in all respects in good shape and CO or carbon are found in the flue gases, the grate surface is too small.

Routine and Rules

TO be effective, the use of the gas analysis apparatus should be made a part of the daily routine of the boiler room and rules should be formulated for the boiler room force based on the findings of the analyses. The force should then be required to live up to these rules and the regular routine of testing of temperatures, drafts and gas analysis should be so arranged that it is as much a part of the business of the plant as cleaning the boilers or testing the safety valve.

Some conclusions reached by the Geological Survey as a result of inspections on plants may well be embodied in these rules. Briefly these are:

With coals high in volatile matter the highest efficiency is obtained when the furace is run at low capacity. With a hand-fired furnace the best results come from frequent firing and small charges. Small coal gives a lower boiler capacity than large, but produces less smoke. Coals which smoke badly usually give efficiencies 3 to 5 per cent lower than those which burn with little smoke, and washed coal, while it burns more rapidly than raw coal and develops higher capacity, usually makes more smoke than raw coal. The rocking grate, with coals that do not clinker excessively, gives 1 to 5 per cent greater efficiency with a smaller percentage of black smoke than the flat grate. Introducing air freely during the time of firing and for a short period afterward increases the efficiency of the boiler and reduces the smoke. Carbon monoxide increases in flue gas as the black smoke increases.

Smoke Record

IN testing the effect of different methods of running, the smoke production is, therefore, a good index of the action of the furnace, and observations and record of the smoke production are advisable. The degree of smoke is determined by comparison of its color with a set of standard diagrams as shown in Fig. 1 and recording the number of the rectangle corresponding the the color of the smoke. This may be conveniently done on a chart of the form shown in Fig. 2 which is a typical record made during and just after a firing of the boiler.

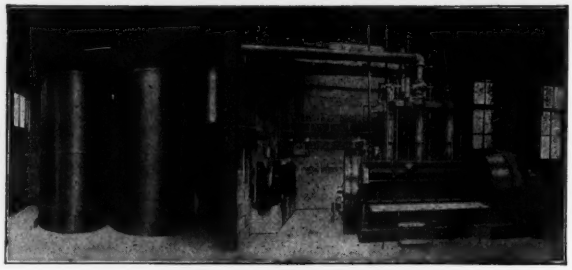
UNDERGROUND NEW YORK

THE rock surface of Manhattan Island slopes from north to south, and passes below the tide level at about Tenth Street. From this point south and below the water level the island consists of a great blanket of sand and silt deposits built up on the underlying rock by the tides and currents of recent geologic times. Beds of clay and sand vary in thickness, and in some places the clay does not appear at all. The sands vary to a considerable degree from the coarsest gravel to the most treacherous quicksands.

To give an idea of the fineness of this sand some samples were passed through sieves with meshes of various sizes, and finally through a 200-mesh sieve, the openings of which are about 0.035 in. in width. From 20 to 37 per cent passed through the 200-mesh sieve. Little may we wonder then that such fine material, when saturated with water, should flow as readily as water itself, passing through every crevice and seeking its level just like any liquid. Herein lies the reason for the difficulties encountered in excavating in quicksands; for, should pumping be resorted to in order to drain a pit of water, this fine material will invariably be pumped with the water, and if the pumping be continued, will finally be drawn from under adjoining structures, eventually undermining them.—Harper's Weekly.

FEDERAL CONTROL OF WATER POWER has been put in serious danger by a contention of Senator Nelson, of Minnesota, that the control of water privileges for purposes other than navigation rests with the states rather than with the federal government. If this proves to be good law, it bars the federal government from undertaking to lease water power rights with provisions to regulate the price to the consumer. The federal government can lease a water power site as land but can make no terms as to the conditions for the development or sale of the power. This opinion of Senator Nelson shows that in many of the Western states a user of water is not compelled to return this water to the stream without injury to other users, but may divert the water entirely and run it into a new channel for placer mining or irrigation.

Gas Producers



And Engines

LONDON LETTER

CRUDE OIL ENGINE

By W. A. Tookey

PROMINENT AMONGST THE BRITISH firms who are engaged in perfecting the crude oil engine for stationary and marine engines, is the Griffin Engineering Co., Limited, of Bath. An improved type of engine has lately been evolved as the outcome of many years experience with similar motors, and in the new engine there are many interesting features which will repay attention.

Mr. Griffin has always made a strong point of so designing the vaporizer that gasification of the oil is never produced—involving as it does chemical changes of the working fluid—but he prefers to rely entirely upon distillation, and takes care that at no time shall there be an excess of heat which will make a chemical change possible. By such means it is claimed that only the volatile constituents of the liquid fuel are permitted to enter the engine cylinders, the incombustible residue being deposited in the vaporizer in the form of a thick tarry fluid and from which it is automatically ejected during the running of the engine.

It is claimed that this system of vaporization will enable any kind of liquid fuel to be employed, including turpentine refuse, creosote, shale oil, Scotch fuel or Texas liquid fuel, all of which can be dealt with successfully without any special adjustment of the engine or of the vaporizer. Even when working with Texas oil, which has a density of 0.9 and a flash point of about

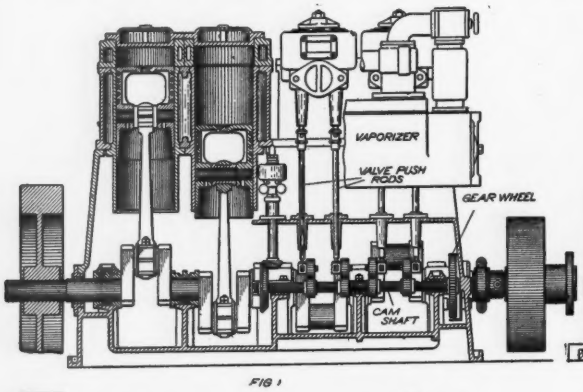


FIG 1

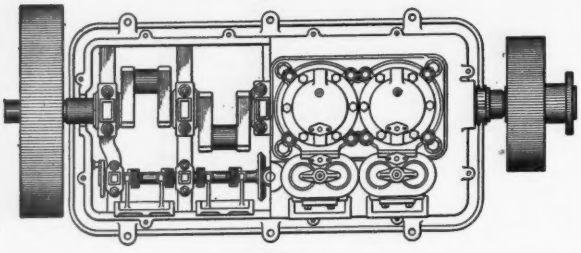


FIG.3

FIG. 1.—GRIFFIN CRUDE OIL ENGINE, LONGITUDINAL SECTION

FIG. 3.—PARTIAL HORIZONTAL SECTION OF GRIFFIN CRUDE OIL ENGINE

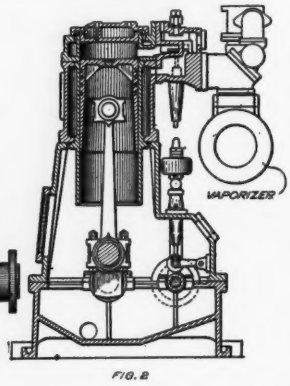


FIG.2

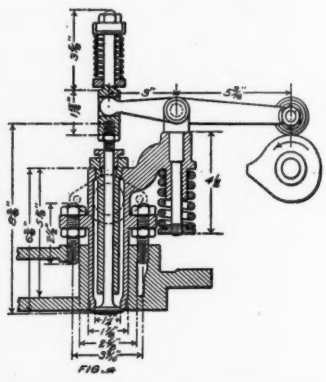


FIG.4

FIG. 2.—VERTICAL SECTION OF GRIFFIN CRUDE OIL ENGINE

FIG. 4.—VALVE MECHANISM

280 deg. F., the engine will run either light or at full load continuously, and at any moment accommodate itself to sudden variations in load.

The accompanying drawings show the general design of a 4-cylinder engine having 10.5-in. cylinders and 10.5-in. stroke, rated at 70 to 75 b. hp. The cylinder casings are cast in pairs, a separate liner forming each cylinder. Compression pressure is about 45 lb. a square inch only, which is found quite sufficient to ensure economical working. The makers guarantee that the fuel consumption shall not exceed ⅝ pint a h. hp. an hour.

Ignition Device

WITH such low compression it is unnecessary to use water injection which was formerly a feature of the Griffin crude oil engines, as the moderation of explosion pressures is now obtained by means of a special patented system of ignition which is called the "Cata-Thermic" ignition. The detail of this system is, for the present, withheld, pending the completion of certain foreign patents, but it includes a timing valve

mechanically operated, which causes the firing of the charge to be delayed until the piston has commenced its outward movement from the inner dead center on the firing stroke, and in this manner the peak of the indicator diagram is eliminated without materially affecting the average mean pressure, at the same time permitting 15 to 20 per cent better fuel economy, as compared with the previous system of water injection.

The vaporizer consists of a long exhaust-jacketed cylinder running the full length of the engine. At 1 end a door is bolted, giving access to the interior and enabling any slight deposit of ash to be easily removed by means of a wire brush. At the other end of the cylinder is a rotatable slide, opened or closed in the manner of an ordinary flush ventilator. In the center of this door, the oil spraying nozzle is fitted, the oil being forced through a small pipe laid on the top of the exhaust-heated jacket, by means of a pump worked by the camshaft. The spraying nozzle is also fitted with a governing rod and a shut-off valve. By means of the latter the fuel supply can be stopped when the engine has completed its run.

Governing Mechanism

THE governor is of the flyball type, situated between the 2d and 3d cylinders in the center of the engine, driven by gear wheels from the camshaft in the usual manner. A rod from this governor acts directly on the spray nozzle connection, reducing the amount of oil supplied to the vaporizer. The control is very sensitive and the small lever actuated by the governor moves through an angle of not more than 50 deg. The lever in question is fitted to a needle-valve screw with 20 threads to the inch, so that, for the full variation between no load and full load, the travel of the inlet valve is only about 1/150 in. Some details of the governing mechanism are also reserved for the present until fully protected by patents.

As mentioned before, the vaporizer is heated by the exhaust gases passing from the cylinders. The bend connecting the vaporizer with the engine-valve chamber being divided into 2 parts, 1 part leading to the vaporizer-jacket and communicating with the exhaust-valve chamber, and the second part leading to the internal bore of the vaporizer and communicating with the inlet-valve chamber.

The engine is fitted with a pump which compresses air to from 20 to 22 lb. a square inch, to spray the liquid fuel through the nozzle into the vaporizer. For starting purposes, a separate hand-operated air pump is used until the desired pressure is obtained. Then the ventilation door in the vaporizer is opened and the fuel supply turned on. The air thereupon blows the oil through the nozzle and a cloud of vapor issues. On the application of a lighted taper, the vapor is ignited and the flame extends the whole length of the vaporizer, rapidly heating it to the temperature required. As soon as it is sufficiently heated, the ventilator door is closed, the flame thereby becoming extinguished. The engine is then started, either by hand or by compressed air stored in a separate reservoir at about 100 lb.

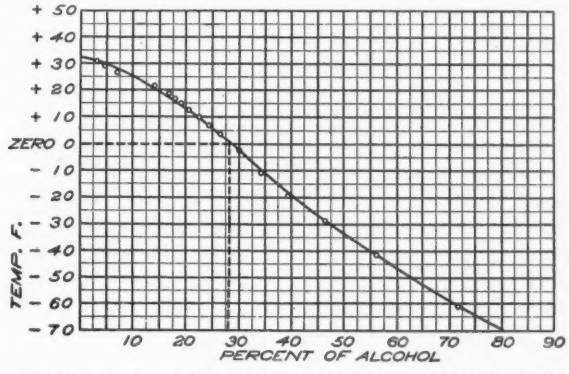
Method of Starting

FOR starting by hand, Mr. Griffin has devised a method to which he gives the name of "Momentum" starter. The flywheel revolves freely on the engine shaft, and a friction clutch attached firmly to the shaft is arranged inside the rim. By means of chain gearing, the flywheel can be put into rapid motion with a few turns of a handle, and while at high peripheral speed, the clutch is thrown in. The momentum of the flywheel then turns the engine over quickly and normal working immediately ensues.

With compressed air starters, the starting valve is fitted to only 1 cylinder of the set. The valve is held against its seat by an external spring sufficient to resist an air pressure of 100 lb. It is operated by a lever by the usual cam arrangement, but the fulcrum, instead of being a fixed point, is spring-mounted so as to yield against abnormal pressures. The cam when starting up, depresses the valve spindle in the manner indicated in Fig. 4, whenever the pressure within the cylinder, at the moment of depression, is less than 100 lb. a square inch, therefore when ignition of a charge has taken place, and the internal pressure exceeds this amount, the valve is prevented from opening, and the movement of the cam lever is absorbed by the stiff spring under the fulcrum pin. Once the engine is fairly under way, the fulcrum is raised by hand, so that the lever stands clear of the cam. It is stated that the new Griffin engine can be stopped for 1.5 hr. and then restarted without reheating the vaporizer.

DENATURED ALCOHOL FOR NON-FREEZING SOLUTIONS

THIS is not the time of year when a nonfreezing solution is necessary in the jacket of a gas or gasoline engine, but as a precaution against freezing during the colder months a mixture of this kind of alcohol with water is found to be effective. The accompanying illustration shows the percentage solution to be used for different degrees of cold likely



PERCENTAGE OF DENATURED ALCOHOL FOR NON-FREEZING COOLING SOLUTIONS

to be encountered. For instance, from the curve it is seen that in zero weather to avoid freezing there should be 28 per cent alcohol in the solution. If the temperature is liable to run down to 10 degrees below zero, 35 per cent must be used. If it is not very cold and the temperature will not go below 20 degrees F., a 15 per cent solution of alcohol and water will be sufficient.

CHICAGO AS A CENTER for business and other movements is growing continually in favor. During May 20 conventions will be held in the city and more than 150 during the next 6 months. From June 12 to 25 a delegation from the Chicago Association of Commerce will visit the cities on Lakes Michigan and Superior to better acquaint them with the advantages that Chicago has to offer as a trading center. The steamer Theodore Roosevelt has been chartered for the trip and will carry an orchestra and all facilities for entertaining the business men of the cities visited.

DEVELOPMENT AND PRESENT STATUS OF PRODUCER-GAS POWER*

HISTORY of producer-gas power in this country began about 1900 with a few scattered plants, which were as a rule only ordinarily successful. This condition lasted for about 4 yr. when through rapid advancement in the improvement of producers and gas engines, the number of installations each year has grown very rapidly, until today the producer-gas plant is taking the place of the steam engine plant in many places.

In the charts, Figs. 1 and 2, are shown graphically the growth and extent of the producer-gas power field. It will be noted that although the number of installations has increased rapidly the total output of these plants has taken a phenomenal stride during the last 2 yr. This is an indication that the gas producer is being used in the large power plants and for large units more extensively today than 5 yr. ago.

One of the most interesting and surprising facts cited in this report is the general distribution of producer-gas power through the country. It is also noted that the application of anthracite producers is not limited to the East. As indicated above there is a tendency at the present time to centralize power for lighting and other purposes in all communities where the demand seems to warrant. Electric lights are now in use in towns numbering their population by hundreds only. These changes and developments in every section are, to a large extent, tending to do away with individual small steam equipment.

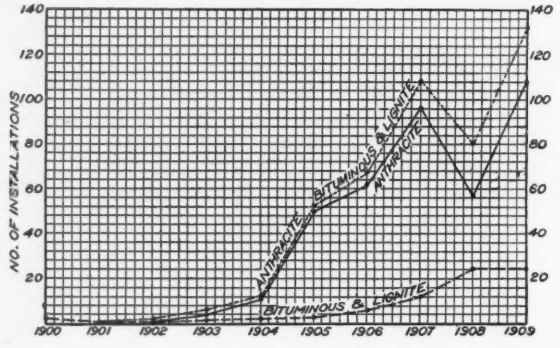


FIG. 1.—ANNUAL INCREASE IN NUMBER OF PRODUCER-GAS POWER PLANTS

In the development of central power plants and the reduction of the cost of power, the producer-gas power plant is an important factor. In this connection the question of locating such plants directly at the mine is well worth careful and unbiased consideration by the engineering profession. The advantages of such locations have already attracted the commercial interest of Europe, and many installations of this character have been made.

There are many conditions in the United States which favor the adoption of this same principle in the location of producer-gas plants. The present agitation for the conservation of our natural resources will stimulate engineers to make use of all refuse that is available for power plant purposes. The supply of fuel of marketable grade is not unlimited, and the prices of such fuel must of necessity be increased. The cost of transporting coal from the mine is high, and the impossibility of obtaining a sufficient supply of cars to handle low grade fuels is questionable. The time is approaching when the cheapest coal obtainable must be used to the best economical advantage in order to develop power at a unit cost consistent with commercial progress.

It has been demonstrated by tests conducted by the Geological Survey that under conditions which do not require the use of steam for other than power purposes, the producer-gas power plant meets the demand for an apparatus which will produce power with the greatest possible economy of fuel known in present day practice. It is also possible with the latest designs of gas producers to use low grade bituminous coal, lignite or peat, and by these means the high grade coal can be saved for other purposes than power.

The logical conclusion from a general study of the producer-gas power situation is that the time is not far distant when financial interests in power production

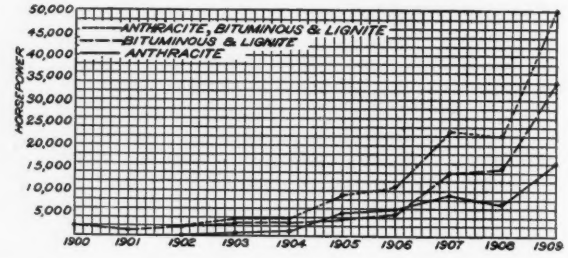


FIG. 2.—ANNUAL INCREASE IN THE TOTAL HORSEPOWER OF PRODUCER-GAS POWER PLANTS

will be directed toward the centralization of the producer-gas power plant at the mine, and the distribution of the energy developed will be accomplished either by high voltage, long distance electrical transmissions or by pipe systems for conveying the gas.

In regard to the fuels which are available for producer gas power plants, it might be stated that many fuels which give poor results under steam boilers have been used with great ease and efficiency in gas producers, which thus makes it possible to utilize low grade coals and lignite that have heretofore been regarded as practically useless. Several of the poorest grades of bituminous coal have shown remarkable efficiency in the gas producer; lignite and bone (a refuse product in bituminous coal mining), mine roof slabs, culm, and washing refuse have also been used to demonstrate the possibility of utilizing such material to advantage in the producer under proper commercial conditions.

Opinions of manufacturers of gas producers and engines in regard to the difficulties in the way of the most rapid development of the gas engine industry indicate that among the most important hindrances is the skepticism regarding the reliability of either the engines or gas producers, due to minor defeats in either, which the makers do not rectify after the plants are sold. Large engines of long strokes become disproportionately high in price, and in the large installations their availability is not so evident unless fuel is very expensive.

*Abstract of a bulletin issued by the United States Geological Survey.

The absence of large overload capacities detracts from the flexibility of operation, so commonly experienced with steam plants. The failure of some gas producer installations is not due to any faulty construction or design, but to the disinclination on the part of the attendant properly to operate the plant or to learn how to do so. The main trouble experienced with the soft-coal producer is the tar which the coal contains.

One manufacturer says that in his opinion, builders of gas producers rate their apparatus too high, and are not able to instruct their customers to operate the plant properly. This latter difficulty, however, is rapidly disappearing as the number of installations increase, and more information is available to the operating engineer through the reports of tests and experiments.

One of the most serious obstacles in the way of more rapid development of producer-gas power plants is the difficulty in obtaining a satisfactory producer which will use practically all grades of bituminous coal, and which at the same time, will not be much more expensive than the ordinary anthracite producer plant. The fact that the heating of factory buildings must be provided for by a heating plant separate from the power plant in cases where producer gas is employed for power is given as one of the difficulties which can never be overcome, and a feature which will decide in favor of steam plants in many cases.

In regard to the reliability of producer-gas power plants it is stated that an examination of the replies received from the manufacturers during the past year showed that only 2 out of 10 regard this point as vital, and 1 of these feels that the difficulty is with the public rather than with the plants themselves.

During the past year a tour of inspection was conducted by the Geological Survey in which a large number of producer-gas plants of all sizes were visited, and in summing up the information it is stated that the plants as a whole are giving remarkable satisfaction considering the brief period of development that has passed since the introduction of this type of power. The most serious difficulty seems to arise from the lack of competent operators to run the plants right than from defects or troubles inherent in the plants themselves. This difficulty no doubt will be eliminated in time, as there are many more competent operators today than 3 yr. ago.

Incompetent salesmen have done a great deal to retard the progress of the gas-producer industry, but this feature is greatly improved, particularly with the stronger companies. The neglect shown by some manufacturers in respect to their plants after they are installed and paid for has not been farsighted, and the failure of manufacturers to give the purchasers or operators of plants full information regarding their construction and method of operation has certainly been detrimental to the business. Experience has shown that such neglect produces serious results and financial loss to the manufacturer, and a decided change for the better has developed within the past few years. There are, however, a few small concerns still operating in the producer field on what may be considered a false basis.

"It has been my experience that the concentration of the mind on the qualities of the article and the need for it in my prospect's business will accomplish more than a long sermon on its good points."—Office Appliances.

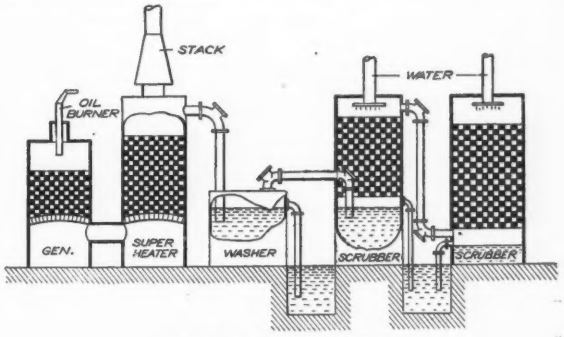
"The world owes each of us a living, but will not pay it until we prove ourselves worthy."

CRUDE OIL GAS OPERATION

By C. E. Trink

To reduce the cost and increase its standard, the operator should endeavor to make as much gas from crude oil at each run as conditions will permit. By so doing he will reduce the firing oil to a minimum. As you will readily understand there is considerable oil used to raise heats. The first heats require more oil than those following, making the cost of the last heat less than the first one. It is also evident that 90,000 cu. ft. of gas can be made quicker at 1 time than at 3 different times.

The actual oil used in making 1000 cu. ft. of the best gas will not exceed 7 gal., so the balance of the oil used must be consumed for heats or steam. From experiments I find that 2 gal. will carry the heats and, on a 90,000-ft. make, 0.75 gal. per thousand should be



CRUDE OIL GAS PRODUCER

ample for the general heating up of the machine. With these allowances it would require 9.75 gal. on the average per thousand.

By close study of the temperature of the machine one will be able to determine the rate which is best for making gas. If the machine is what is known to operators as "good and hot" give it all the oil it will take without blowing the stack valve, thus causing the gas to leave the machine rapidly.

It will carry with it a large percentage of the heavy hydro carbon which is so essential for light and heat. Running slow produces a poor gas if the heats are up, besides compelling the flooding of the generator to get even a fair grade of gas.

The oil used contains an average of 18,750 B. t. u. per lb., weighing 7.75 lb. per gal., and 7 gal. are required for each 1000 cu. ft.; this would amount to 1,017,000 heat units that go into the machine for gas making. There is produced from this 16.6 lb. lamp black. That contains 13,800 heat units per lb., so $16.6 \times 13{,}800 = 229{,}000$ which will leave 788,000 B. t. u. for each 1000 cu. ft. gas or 788 for 1 cu. ft. The gas required contains 650 B. t. u. per cu. ft., so on 7 gal. there is a large margin. When 90,000 cu. ft. of gas are made there are produced 1494 lb. of lamp black which if fired under a steam boiler with judgment will generate 38-h.p. per hr. for 12 hr. or 1400 lb. dry lamp black is equal to 160 gal. of oil. The lamp black should be sufficient to handle the machinery, such as the compressor, oil pump, engine and blower necessary for operating the plant.

To cut down the time of blasting out the generator, wide spaces between the checker brick should be provided, at the bottom not less than 6 in., and this construction continued so until a point 1 ft. above the nozzle, then close in to 2.5 in. check, keeping the flues in true line.

THE SELECTION OF A GAS ENGINE

By A. E. Palmer*

THIS article will endeaver to set forth in a short, concise manner and plain language a few facts with respect to the design of the various types of motors and a few advisory remarks relative to the adaptability of types for certain purposes.

Qualifications to be Considered

THE first thing to consider is the amount and kind of work that the engine is to perform. Simplicity of operation, ease of control and light weight are 3 very important factors that should be strongly borne in mind by the prospective buyer, although first class material and workmanship should not be lost sight of for a minute.

If the engine is used for stationary purposes such as driving a line shaft or an electric generator, it is not necessary to obtain a heavy type of engine as the light high-speed motor will often give better satisfaction. If the motor is installed in the second or third story of a building, this question of weight must be thought of and very carefully too, for the floor may not be strong enough to sustain the load of the heavy engine or the building may be so constructed that the vibration of the tremendous mass of the heavy motor under the force of an occasional explosion might be transmitted to all parts and not only weaken the building but cause annoyance to the other occupants.

The stationary engine should be fitted with suitable governor, capable of regulating the speed as close as 2 per cent between no load and full load. A steady force to the crank shaft diminished in amount only is far superior to an occasional impulse whose force is constant.

Increasing the number of cylinders decreases the vibration of a motor and produces a torque that more nearly approaches that of the electric motor thus insuring steady running. There should be as few working parts as possible and the ignition lubrication, vaporization, and the cooling systems should be simple and all parts of the motor easily accessible in case of a break down or repairs.

The Portable Engine

IF THE engine is to be used for portable work, the question of lightness is one of the first considerations. Some makers are putting out a complete power plant that can be set upon a platform and the whole affair can be easily carried by 4 men from place to place as occasion demands. The motor and its accessories such as the cooling tank, the gasoline tank and the ignition and oiling systems should be compact and all parts should be as light as possible consistent with strength.

The water tank should be large enough to carry a supply of water that will just do the work, no more, no less. Of course in the case of the water tank, the water may be easily removed if it is desired to move the plant. The gasoline tank, however, should be designed with the idea in view that it is not to be drained every now and then in order to lighten the load, for it is not convenient to do so. The tanks should therefore be made to such a proportion as to carry a good supply and yet not too bulky or heavy.

Generally speaking, the portable motor does not need a governor, depending of course upon the class of work it is required to do. The flywheel should be just heavy enough to carry the engine over the compression and that's all. Any additional weight will simply tend to increase its awkwardness. The portable motor is usually good for outdoor work and is more or less subjected to rain storms and dampness. In view of this fact, the make and break system of ignition will give the best satisfaction because there is less liability to short circuit through moisture with it, than with the jump spark system.

*Mechanical Engineer, Ferro Steel & Foundry Co.

Marine Motors

IN CASE of the marine motor, the question of vibration again arises and must be carefully considered. The statements relative to light weight, simplicity and ease of control apply to the marine motor. The engines should be as small as possible, consistent with the power developed as the necessity of available space in all motor boats is a predominating feature. If the motor is to be used in an open boat or on salt water, the make and break system is to be recommended for the same reason that was brought out under the head of portable engines.

Automobiles

IF THE motor is to be installed in an automobile, the secret of good design is to furnish "maximum power and minimum weight" and the motor must fulfill these conditions in order to give satisfactory service. Of necessity, the motor must be of the high-speed type and must admit of an extraordinary degree of accessibility as well as being extremely simple; the simpler, the better. The motor must possess flexibility and be able to pick up rapidly under full load.

All bearing surfaces must be amply large to accommodate the tremendous speed of the various parts, and all parts that are subjected to the heat of the exhaust should be well cooled. It frequently happens that on 4-cycle motors the exhaust valve becomes so hot as to warp it out of position to such an extent as to cause a leak at the valve seat, which, of course, is detrimental to the proper working of the motor. Some makers are overcoming this undesirable feature by placing in the cylinder an auxiliary exhaust port through which the hottest gases escape before the exhaust valve opens.

BELT POINTERS

A FOUR-PLY stitched canvas belt should not be run over less than a 6-in. pulley; a 5-ply over less than a 9-in. pulley; nor a 6-ply over less than a 12-in. pulley. Any diameters less than these will cause your belt to cut itself in making the short bends necessary to turn the pulleys.

Any form of belting will give best results at speeds of 3,500 to 4,500 ft. a minute.

Always have your pulleys lined-up, that is, the pulley centers and axes of your shafts parallel.

Wherever possible, have your belt drive from the top. This will make your belt "belly" on the top side, so that it will give a more complete contact on the driven pulley, unless the belt is to be run crossed, as in case of separators.

Use as large pulleys as practicable, as the more contact the belt has on your driven pulley, the more power your belt will deliver; in other words, a small driven pulley will give you speed, while a larger or wider one will give you less speed, but more power.

A belt in proper proportion always runs with an even fullness on the side from which it is driven.

If a constant vibration is seen on the driven side of a belt, the belt is too light for the work—Sawyer Belting Booster.

VALVE DIAGRAMS

FINDING THE EVENTS OF THE STROKE; ADMISSION, CUTOFF, RELEASE, COMPRESSION

WHEN THE PORT OPENING is zero, the valve is just opening or just closing. If just opening, we have admission, and if just closing, we have cutoff. To locate these 2 crank positions it is necessary to find where the opening becomes zero.

By studying the diagram, it is evident that this condition is found when the crank line just touches the lap circle, and as there is lead, the admission position will be found below the dead point, at A Fig. 4. This is found by drawing a line through O and touching the lap circle at a.

tive lap as in Fig. 3, April issue, 9/32 in., the lap circle is drawn and the lines OrR and mOM tangent to it. The position R is the release for the head end on the forward stroke and the position M is compression or exhaust closure for the head end and comes on the return stroke.

Comparison of Diagram With Valve Action

TO get clearly in mind the relation of the diagram to the valve action, it is best to trace through the events of a stroke. Starting with the valve in midposition, as at 4K and the eccentric vertical, as at v Fig.

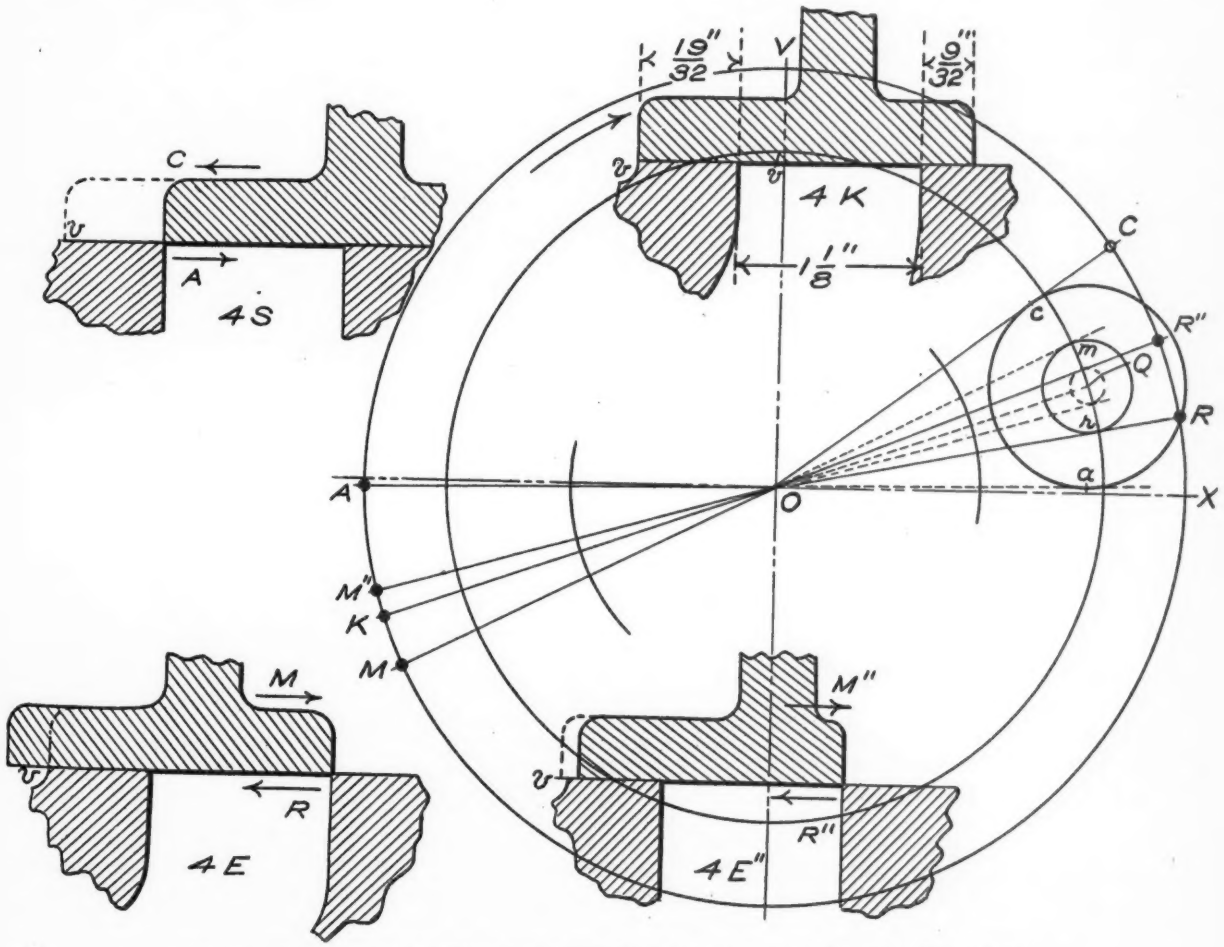


FIG. 4.—FINDING STEAM EVENTS FROM THE DIAGRAM AND ANALYSIS OF VALVE ACTION

After the crank passes the vertical position OV, the valve displacement is found on the same side of the center O as the crank position. The position for cutoff will therefore be C Fig. 4.

Release and Compression

IN like manner, the points where the exhaust valve opens and where it closes, i. e. release and compression are found by drawing crank lines touching or tangent to the exhaust lap circle. Taking the same position as in Fig. 4, the crank will be at K. The crank line will pass through the center Q of the lap circle, showing that the valve is in midposition.

As the crank moves forward, the crank line moves away from the circle center, and the valve displacement will increase until this displacement is equal to the lap of the valve and the crank line is tangent to the lap circle. The crank will then be at A Fig. 4, and the valve in the A position shown in 4S, moving to open. This is the admission point. With further mo-

tion of the crank, the valve opens to admit steam and the displacement increases, opening the valve wider until the crank is perpendicular to OQ when the opening is greatest.

From that time, the valve moves to close until the displacement is again equal to the lap and the crank line is tangent to the lap circle at c when the valve closes and cutoff occurs. The valve then stands as shown at C on 4S.

From crank position A to position C the valve is open and steam is entering the cylinder. After cutoff, steam expands and the piston moves forward, the valve moving to the left until it has passed midposition by the amount of the exhaust lap.

As the crank moves forward, the crank line comes tangent to the exhaust lap circle on the upper side, but the valve has not reached midposition, so it is evident that the exhaust could not open at that time. So long as the exhaust lap is positive, the port can open to let out the steam only after the valve has moved to the left past midposition by the amount of the exhaust lap and the crank line comes tangent to the exhaust circle at the bottom. The crank position for release will then be R and the valve will stand as at R in 4E.

With forward motion of the crank, the valve opens the exhaust port wider until the crank again is perpendicular to OQ and below the horizontal when the exhaust port opening is maximum, and from that time the valve moves to the right to close the exhaust. When the crank line (in this case prolonged) again comes tangent to the exhaust lap circle, the valve will be in position shown at M in 4E and the crank in position OM. From this time the valve will move to the right, and the steam will be compressed in the cylinder until admission takes place.

Effect of Negative Exhaust Lap

IN both 4S and 4E the dotted position v of the valve steam end indicates midposition, and the distance that the valve has moved is shown by the distance of the steam end of the valve from v. In 4E the valve is to the left of midposition when release and compression take place. It has passed midposition before release occurs, and has not reached that position when compression begins.

In the case of negative exhaust lap, the valve at midposition will be as shown dotted in 4E″ and it is evident that the valve will open exhaust before it has returned to midposition from the right. Looking at Fig. 4, the release point will come when the crank line comes tangent to the dotted exhaust lap circle on the upper side, and the crank position for release will be at R″. Compression, on the other hand, will not occur until the valve has passed midposition moving to the right and will be found when the crank line prolonged comes tangent to the bottom of the exhaust lap circle. This will be crank position M″.

Comparing the position of the valve with v or midposition in 4E″ it is seen that the valve is to right of v for both release and compression.

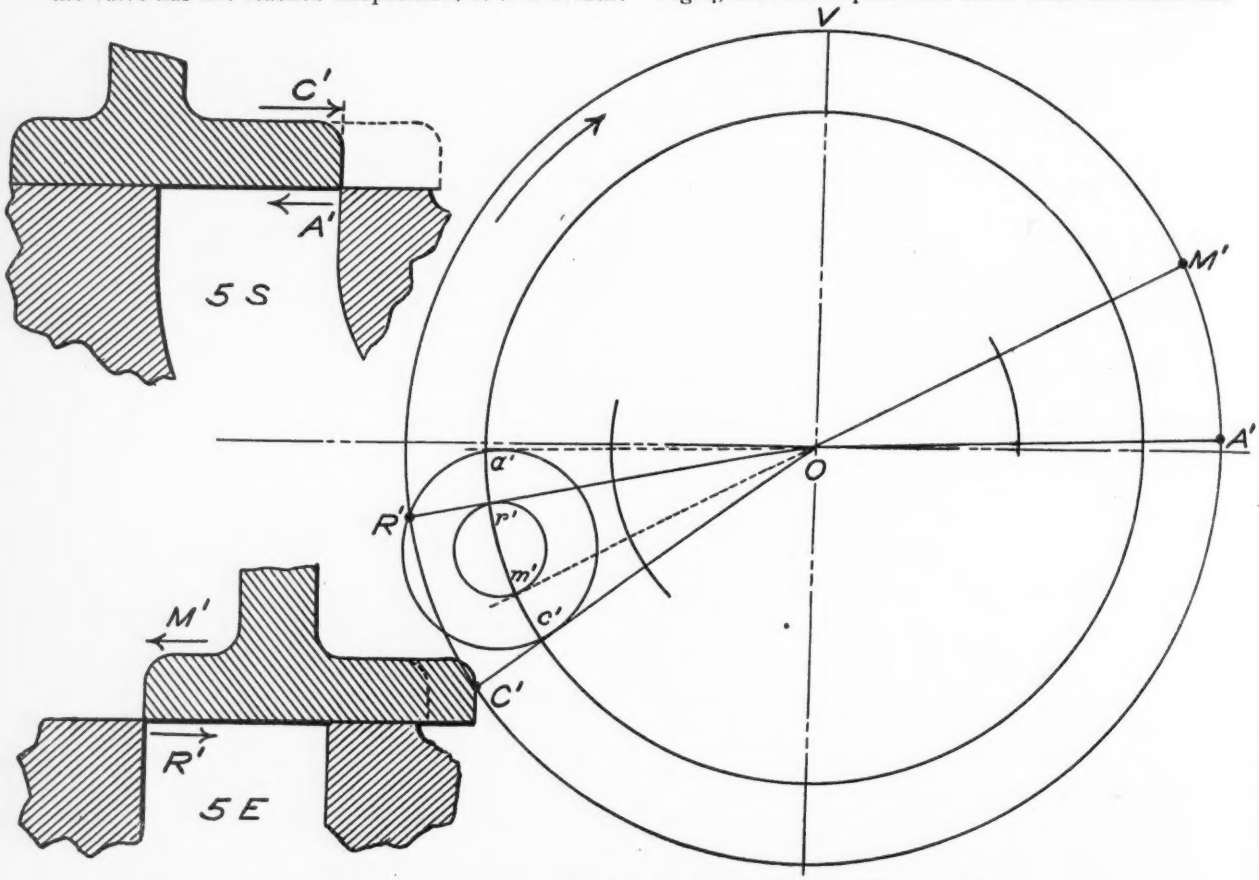


FIG. 5.—EVENTS AND VALVE POSITIONS FOR CRANK END OF THE CYLINDER

Crank End Events

THE action for the crank end of the cylinder might be found from the same lap circle, if the laps for both ends of the valve are the same. It would make, however, a confused diagram because of the great

number of lines, and usually the laps are not the same. The angle of advance must be the same, but in order to get the cutoffs as nearly equal as possible at the 2 ends, the laps are made different.

Fig. 5 shows the lap circle for the crank end of the cylinder with the laps the same as for the head end

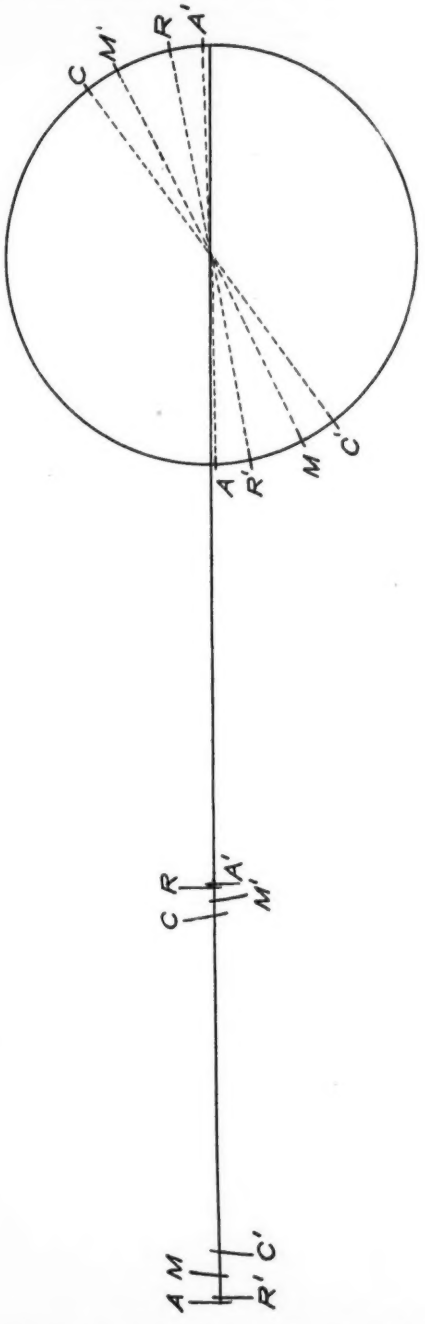


FIG. 6.—UNEQUAL CROSSHEAD POSITIONS FOR EQUAL LAPS ON BOTH ENDS OF THE VALVE

and with the crank positions and the valve positions indicated as follows: Admission, A′; cutoff, C′; release, R′; compression, M′. Positive exhaust lap has been taken.

To show the effect of equal laps on the 2 ends, Fig. 6 has been drawn, the crosshead positions having been found from the crank positions. These are the same as the piston positions and show that the cutoff and release come later and the compression earlier in the stroke for the head end than for the crank end of the cylinder. Admission is practically the same for both ends.

It will be seen by later study of the diagram that this inequality can be remedied to a considerable degree by letting the head end have late admission and negative lead, and also that this is needed to get early cutoff with a plain D valve and single eccentric.

SPLICING THIMBLE ON WIRE ROPE

By Fred G. Kuhn

THE first step in splicing a thimble on a wire rope is to make fast the end and put the wire on a slight stretch, then redlead that part of the wire that is to go around the thimble. Now take spun yarn, which is small stuff spun left-handed and consists usually of 3 yarns, and worm the wire the length it is to go around the thimble, leaving enough ends to worm the splice after it is made. Now parcel

FIG. 1

FIG. 2

FIG. 1.—METHOD OF WORMING WIRE ROPE
FIG. 2.—PARCELLING WIRE ROPE WITH MUSLIN

over the worming, i. e., take about 2-in. strip of muslin and pass it around the wire over the worming as in Fig. 2.

Next serve over all with spun yarn with a serving mallet as in Fig. 3. The rule for the above is: Worm and parcel with the lay of the rope, then turn and serve the other way; i. e., against the lay. Without a wire vice, seize in the thimble, i. e., tie the part that

FIG. 3

FIG. 4

FIG. 3.—SERVING SPUN YARN
FIG. 4.—METHOD OF MAKING SERVING FAST

has been wormed, parceled and served around the thimble as at A, B and C, Fig. 5, then unlay the strands of the wire rope.

As there are 6 strands lay 3 on each side of the part that you are going to tuck into as in Fig. 5, and we will number the strands 1, 2, 3, 4, 5 and 6, from left to right. Put No. 1 through the center using a pricker to open the lay; No. 2 goes in where No. 1 does but under only 2 strands; No. 3 under 2 strands, etc., until the 6 strands are all tucked the first time, then take out part of the strands, about ¼ the number,

and tuck over one and under one, then divided the strands and tuck over one and under one again, then cut off the ends snugly, redlead the splice, and continue the worming with the spun yarn, which should have been left long enough to worm with; parcel and serve over the splice, and it is then ready for use.

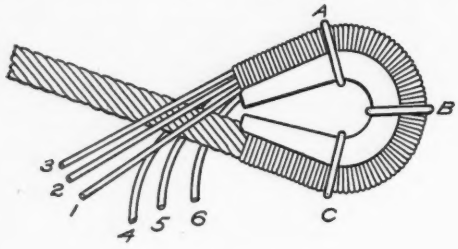


FIG. 5

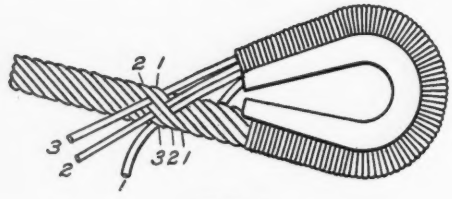


FIG. 6

FIG. 5.—SEIZING THE THIMBLE
FIG. 6.—TUCKING THE STRANDS

BELT FACTORS

FOR CALCULATING HORSEPOWER AND WIDTH

By William W. Bird*

THE QUESTION of the proper size of a leather belt for a given power transmission resolves itself into a question of selecting various factors. These factors have been worked out by experiments, by analytical methods, and in practice, and this article will simply deal with the facts established and endeavor to put them into convenient form for use in actual practice.

The horsepower that a belt will transmit depends upon the effective tension and the belt speed. The effective tension depends upon the difference in the tensions of the 2 sides of the belt and on the surface friction, which depends upon the ratio of the tensions and the angle of wrap.

Maximum Tension

EXPERIMENTS and practice have shown that a belt of single thickness will stand a stress of 60 lb. per in. of width and give good results, that is, it will only require an occasional taking up and will have a fairly long life. The corresponding values for double and triple belts are 105 and 150 lb. per inch of width, provided the pulleys are not too small.

Ratio of Tensions

ON small pulleys experiments have shown that the ratio of the tensions should not exceed 2, on medium pulleys 2.5, and on large pulleys 3. The larger the pulley is, the better the contact is; the thinner the belt is, the better the contact is for the same size of pulley. When the pulley diameter in feet is 3 times the thickness of the belt in inches, or in this proportion, we get equivalent results for different thicknesses of belts. This gives us a method of classifying our pulleys. The belt has to adjust itself in passing over a pulley due to its own thickness. Some adjustment is also necessary on account of the crowning of the pulley. These adjustments account for the different ratios for the various pulley diameters. The effects of the crown and pulley diameters are not usually considered in belt rules, which is a grave mistake. The ratios are for 180 deg. wrap and decrease with less contact.

TABLE I.—VALUES OF BELT FACTORS FOR 180 DEG. ARC OF CONTACT WITH PULLEY

Diameter of Pulley	Under 8"	8"–36"	Over 3 feet	Under 14"	14"–60"	Over 5 feet	Under 21"	21"–84"	Over 7 feet
Thickness of Belt	Single	Single	Single	Double	Double	Double	Triple	Triple	Triple
Factor	1100	920	830	630	520	470	440	370	330
Difference of Tensions	30	36	40	52.5	63	70	75	90	100
Per Cent. of Creep	.74	.89	.99	.74	.89	.99	74	.89	.99
Ratio of Tensions	2.00	2.50	3.00	2.00	2.50	3.00	2.00	2.50	3.00
Tension on Tight Side	60	60	60	105	105	105	150	150	150

Difference of Tensions

THE creep of the belt depends upon its elasticity and the load, and experiments have shown that this should not exceed 1 per cent in good practice. In order to keep this creep below 1 per cent it is necessary to limit the difference of tension per inch of width of single belt to 40 lb. The corresponding values for double and triple belts are 70 and 100 lb. per inch of width. These figures are based on an average value of 20,000 for the running modulus of elasticity of leather belting.

TABLE II.—VARIATION OF BELT FACTOR WITH ARC OF CONTACT

220°	210°	200°	190°	180°	170°	160°	150°	140°	130°	120°
980	1010	1040	1070	1100	1140	1180	1220	1270	1330	1400
810	830	860	890	920	950	990	1040	1100	1170	1240
730	750	770	800	830	860	890	930	980	1030	1100
560	570	590	610	630	650	670	700	730	760	800
460	470	480	500	520	540	570	600	630	660	700
420	430	440	450	470	490	510	530	560	590	630
390	400	410	420	440	460	480	500	520	540	560
320	330	340	350	370	390	410	430	450	470	490
290	300	310	320	330	340	360	380	400	420	440

Table I has been prepared on the basis of these limitations and gives a value for the factor in the rule: Horsepower equals belt velocity in feet a minute times belt width in inches divided by the belt factor from tables. Width required in inches equals horsepower

*Director of the Department of Mechanical Engineering, Worcester Polytechnic Institute. This article reprinted from The Journal of the W. P. I., January, 1910.

to be transmitted times belt factor divided by belt velocity in feet a minute.*

Table II gives corrected values for the factor when the arc of contact or wrap is greater or less than 180 deg. On large pulleys the creep may exceed 1 per cent if the wrap is over 180 deg., as the increased friction gives a greater difference of tensions.

Problems Solved

TO illustrate the use of the tables, we will take the following examples:

How much horsepower will a 4-in. single belt transmit at a speed of 4600 ft. a minute passing over a 12-in. pulley? The factor is 920, therefore

$$4600 \times 4 \div 920 = 20 \text{ hp.}$$

How wide should a belt be in order to transmit 50 hp. at 2000 ft. a minute on a 36-in. pulley?

$$\text{Width} = 50 \times 830 \div 2000 = 20.7\text{-in. single belt.}$$

This gives us a width of single belt which is beyond the usual limit, 8 in. being considered good practice for the maximum width of a single belt.

$$\text{Width} = 50 \times 520 \div 2000 = 13\text{-in. double belt.}$$

How wide should a single belt be in order to transmit 2 hp. at 600 ft. a minute over a 4-in. pulley with 140 deg. wrap?

In this case we take the factor 1100 from Table I and in Table II find a corrected value for 1100 under 140 deg. of 1270.

$$\text{Width} = 2 \times 1270 \div 600 = 4.23\text{-in. single belt.}$$

How wide a belt is required for 300 hp. at 2000 ft. a minute over 10-ft. pulley?

$$\text{Width} = 300 \times 470 \div 2000 = 70.5\text{-in. double belt.}$$

This is too wide. Good practice calls for a change to triple at 48 in. unless for some special reason a narrower belt is necessary.

$$\text{Width} = 300 \times 330 \div 2000 = 49.5\text{-in. triple belt.}$$

The belt speed is limited by centrifugal force, but below 5000 ft. a minute the loss on this account is largely compensated for by the increase of friction due to the shorter time of the contact, caused by the increased velocities.

The results given by these factors are well within working values and the belts will probably transmit 50 per cent more power than these factors give, but at the expense of the life of the belt. A liberal allowance at the beginning means less annoyance, fewer delays in taking up the belts, longer life and less cost for renewals and repairs.

*$HP = \frac{V \times W}{F}$ or $W = \frac{HP \times F}{V}$

in which HP is the horsepower, V the belt velocity in feet a minute, and W the width in inches.

NOTABLE DATA FROM AN ISOLATED PLANT

FROM the factory of Wilcox Crittenden & Co. of Middletown, Conn., the data following has been furnished to The Isolated Plant, and shows a remarkable performance as well as giving unusually complete figures of costs and results. In the letter of transmittal the company calls attention to several points as follows:

You will note that we have made a charge of every conceivable item, including 5 per cent interest and 5 per cent depreciation on machinery, tools and real estate. Our plant consists of a 250-hp. Hazleton boiler with an American boiler economy regulator and pump governor, which maintains the water level; 250-hp. Ames tandem-compound condensing engine direct connected to a 150-kw. General Electric, 400-volt, 2-phase, 60-cycle alternating-current generator. We have 7 independent motors in our different departments which are supplied with current, and also a lighting circuit which is transformed from 400 down to 110 volts for general illumination.

Engineer's Report for Months of 1909

	Amount. Aug.	Amount. Oct.	Price.	Cost. Aug.	Cost. Oct.
Lb. Cumberland Coal	103,600	117,000	$4.63	$212.96	$240.27
Qt. Engine Oil	8	16	0.06½	0.52	1.04
Cu. Ft. Water	12,362	11,890	0.06	7.42	7.13
Qt. Cylinder Oil	24	20	0.09½	2.28	1.90
Lb. Waste	5	26	0.07½	0.38	1.95
Engineer and Labor	.....	.....	....	108.00	109.90
Depreciation, Real Estate	$4,000	.....	%5	16.67	16.67
Depreciation, Tools and Mach'y	$14,000	.....	%5	58.33	58.33
Interest on Plant and Equipment	$18,000	.....	%5	75.00	75.00
Total				$481.56	$512.19

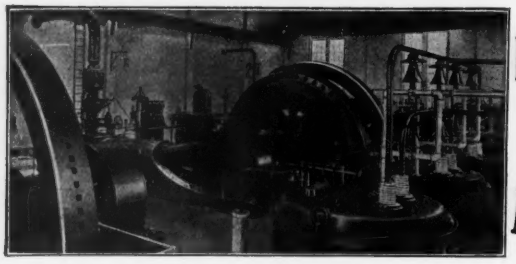
	August	October
Waterwheel run, days	3.5	6
Steam on Buildings, days	3	24
Ash	lb. 11,099 %10.7	lb. 12,434 %10.7

In reference to our water wheel, this is a turbine wheel, that is connected to the pulley of our engine with a quarter turned belt, thereby helping out the engine with about 38 hp. when our reservoir is full. You will note that during the month of August our water wheel ran 3.5 days. During the month of October it ran 6 days. In our opinion this water wheel would not average us more than 15 or 18 hp. during the time operated, as we have never had a full head of water on.

	1908. Kw.-Hr.	1908. Cost.	1909. Kw.-Hr.	1909. Cost.
January	.....	.....	22,070	0.02371
February	.....	.....	22,180	0.02395
March	.....	.....	27,220	0.02023
April	.....	.....	25,560	0.01906
May	23,970	0.01986	22,700	0.02057
June	27,760	0.01733	23,490	0.01997
July	96,600	0.01602	25,280	0.01823
August	27,530	0.01736	26,390	0.01825
September	27,830	0.01601	25,960	0.01809
October	26,180	0.02095	26,330	0.01945
November	22,360	0.02289	.....	.....
December	24,960	0.02164	.....	.....

"TRAIN YOUR MIND to think accurately—and your hand to respond quickly."

ELECTRICAL



MACHINERY AND APPARATUS

SELF-GOVERNMENT OF ELECTRIC MOTORS

WHY THEY DO NOT REQUIRE GOVERNING DEVICES

By L. S. Le Tellier

RECENTLY AN EXPERIENCED MOtor tender asked me why it is that electric motors do not have governors. He had observed that motors under his care worked under variable loads, yet however great or sudden the change, it appeared that the speed of the motor showed no great variation from normal; whereas it was a matter of common observation that in a steam engine and other forms of motors it was necessary to provide a special governing attachment to regulate the speed under changes of load. After explaining the principle of selfgovernment in the motor to the man in question it occurred to me that a large number of practical men might be interested in the same explanation, so it is herein given.

In the steam engine throttling of the steam corresponds to increasing or decreasing the electric current

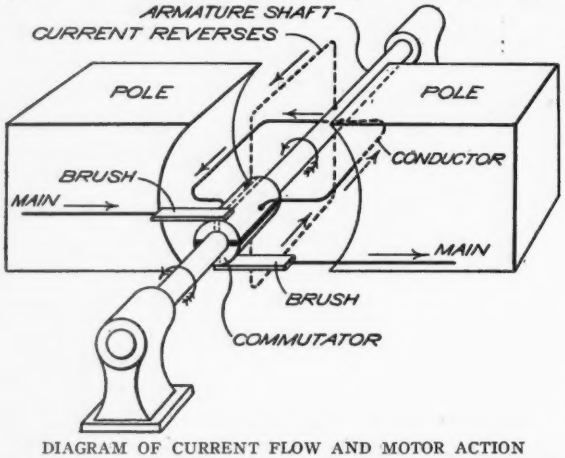


DIAGRAM OF CURRENT FLOW AND MOTOR ACTION

used when the load on a motor is increased or decreased as the case may be. It is obvious that the current consumption is greater with a full load than with a smaller load, yet apparently no provision is made to adjust this current supply to the requirements of the load. In order to show how this is accomplished it will be necessary to give a brief explanation of the underlying principle of dynamo-electric machinery.

Principles of Motor Action

AN ELECTRIC current is generated by causing a closed circuit to move across or revolve in a magnetic field. To make clear what is meant by this, consider the ordinary permanent horseshoe magnet. It is a matter of common observation that in the vicinity of the toes of the horseshoe there is some kind of a mysterious force being exerted; to express it more technically, lines of force are passing from one pole of the magnet to the other. A space in which these lines of force are present is called a magnetic field.

Now, if we form a piece of wire into a closed loop and pass a portion of this loop through this magnetic field so as to cut lines of force, a current will flow in the wire. Furthermore we have to exert a greater force on a wire loop to move it across a magnetic field than to move it through the air without the field. The energy represented by this additional force is transformed to energy represented by the current which flows in the wire.

This is the fundamental principle of the electric generator. Why this strange thing called an electric current is produced by this operation is a matter which has never been explained, yet all electric generators—except such forms as batteries—do nothing but pass closed circuits through a magnetic field and thereby generate an electric current; or, as an electrical engineer would express it, generate an electromotive force which will cause a current to flow if the circuit is closed.

Reaction Between Current and Field

ON THE other hand, if instead of forcing a portion of a closed circuit through a magnetic field, we pass a current through this circuit from some other source, there is produced a force which tends to push the circuit out of the field. This is just the reverse of what happened in the generator, for in that case we supplied the force and caused the current and in this case we furnished the current and the force on the wire was the result.

It is of interest to note here that the direction of the force exerted against the wire depends upon the direction of the current in the wire and, if the direction of the current is reversed, the direction of the force is also reversed. Where the current is supplied and the force is exerted on the wire or conductor we have a crude motor. The typical motor is nothing but a number of conductors in a magnetic field so arranged that when a current is passed through the conductors the force exerted on them is made to rotate the shaft of the motor. In this case when a current is passed through a conductor in one direction the tendency is to force the conductor out of the field, but by reference to the diagram it will be seen that the current in the right

hand side of the loop is in one direction and in the left hand side the direction is reversed; therefore, the forces tending to push the 2 portions of the conductors out of the field are in opposite directions, hence rotation is produced in the shaft until the loop reaches a vertical position, shown dotted. At this point the direction of the current in the conductor is reversed by the commutator and the forces on the upper and lower portions of the conductor are also reversed. It is easy to see that this will give continuous rotation to the shaft.

An electric motor is nothing but a series of such conductors mounted on the armature between the poles of an electromagnet and so arranged that a current may be passed through them, and as each conductor passes the vertical position shown by the dotted lines in the figure the current is reversed. We are now prepared to explain the principles of self-government in the motor.

Counter Electromotive Force

IT WAS stated in the beginning that a closed circuit or a portion of a closed circuit moving in a magnetic field so as to cut across lines of force causes a current to flow in that circuit. This is a generator. On the other hand, if we supply the current there is a force tending to push the conductors out of the field. This is a motor. But in the second case, where rotation is produced by passing a current through the wire, the resulting rotation of the wires will also cause them to cut lines of force just as they did in the generator when we were rotating the conductors mechanically.

That we are here rotating them by passing a current through them does not alter the case. The essential fact is that we are cutting lines of force by a conductor, and, according to our original statement, this should generate or tend to cause a current to flow in the conductor. This is exactly what happens, and in this respect the motor acts like a generator. Now since we are passing a current into the wire, it is interesting to note what effect this secondary current will have.

The tendency to produce this secondary current is known as the counter electromotive force (c. e. m. f.), and it acts in the opposite direction to the current which is passed into the wire from outside. That it is opposed is obvious because, if it were not, then this additional current produced in the machine would increase the flow in the conductor, which would increase the speed of the machine which in turn would increase the c. e. m. f. and so on indefinitely. This, of course, is impossible, as we would be producing a continual increase in the power developed by the motor. Therefore, we conclude that part of the current passed into the conductors from the mains is wasted in overcoming this c. e. m. f.

Keeping the above facts clearly in mind we will proceed to show how this c. e. m. f. acts as a governor for the motor. It is clear that the faster the conductors turn in the magnetic field the greater will be this c. e. m. f. or, if we increase the speed of the machine, the retarding counter force is increased and, if we decrease the speed of the machine, it is also decreased.

It is also clear that the pull exerted on the shaft by the conductors is determined by the amount of current which is passed through the conductors in the armature. In other words, if there is a heavy load on a machine it is desirable that a greater amount of current flow through the conductors from the mains from the the power house, just as in the steam engine a greater amount of steam is required from the boilers when a greater load is thrown on the engine.

Speed Regulation

NOW how is the amount of this current flowing regulated by the counter electromotive force? Suppose that a motor is running under a light load and a heavy load is thrown on. This will cause a temporary decrease in the speed of the motor, but this decrease in speed will cause a corresponding decrease in the c.e.m. f. generated. In other words, the resistance to the flow of the current from the mains is cut down, hence more current will flow into the conductors. This increased current will enable the motor to resume its normal speed under the increased load.

Then suppose that the load is suddenly thrown off. This will cause a temporary increase in the speed of the motor, but this increase will increase the c.e.m.f. which in turn will cut down the amount of current flowing in the conductors, thus causing the motor to return to normal speed.

From the above, it will be seen that the counter electromotive force will act as a governor, and in practice it will be found to be far more satisfactory than the special attachments which are devised to govern steam engines and other forms of motors.

STURTEVANT DUST BLOWING SET

FOR blowing out dirt and dust from machinery and from around motors, switchboard, shelving, and other places difficult or dangerous of access, the B. F. Sturtevant Co., Hyde Park, Mass., has brought out a new portable dust blowing set. The device is electrically driven and weighs only 55 lb. It is easily portable and is adapted for attachment to lighting sockets, so that the range of its usefulness in manufacturing plant or elsewhere is very broad.

While the blower does not give as high a pressure as the large compressed air systems, the larger volume of air accomplishes in most cases the same purpose without the severe blast. There is an additional advantage derived from the larger volume of air in the speed with which the work is accomplished.

The set includes a 12-ft. length of 1.25-in. flexible reinforced air hose and a 10-in. tapered polished aluminum nozzle. A 20-ft. electric light cord is furnished and in combination with the hose gives a working radii of 32 ft. from a lighting socket.

STURTEVANT DUST BLOWING AND SUCKING SET

As a vacuum cleaner the set may also be employed for suction cleaning where the dust collector is not necessary. For this work one end of the hose is attached to the inlet of the fan, while the vacuum cleaner tool is fixed to the other. The fan will suck the dust through the wheel and discharge it at the outlet or through a hose connected thereto which is led out of doors.

Bulletins describing these sets can be secured by addressing the Sturtevant Co., either at Hyde Park, Mass., or any of its branch offices.

REWINDING AN ARMATURE

FINDING THE PITCH AND MAKING WINDING TABLE

FREQUENTLY, in plants where motors are employed, accidents occur which cause the armature coils to burn out, or become damaged to such an extent that the armature must be rewound. This duty usually falls upon the engineer, especially in small plants where an electrician is not employed all the time. The task is rather difficult, particularly if the coils or end connections have been so badly destroyed that they cannot be followed out, and a man who has not had training in an electrical shop will need more definite instructions than can be obtained in general rules on armature windings and connections.

In order to illustrate the general problem and at the same time give specific directions as to the method of procedure, we have selected the following problem

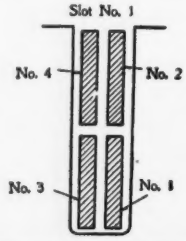


FIG. 1.—ARRANGEMENT OF CONDUCTORS IN SLOT

the solution of which will serve as directions to be followed out in winding all armatures of the same general type.

The armature in this case is for a 5-hp. motor which has 50 complete coils, 50 slots, 99 commutator bars, 4 leads from each complete coil, 4 brushes and 4 field poles.

The Coils

IN THIS case all 50 coils are wound in exactly the same manner, each coil being composed of 2 separate sections wound in the same cell but without electrical connection. Since there are 50 slots and 50 coils each slot will contain 1 side of 2 separate complete coils, which in reality means that there are 4 conductors to each slot. This being an armature for a 4-pole machine the throw of each coil will be from slot 1 to slot 13, that is, coil No. 1 will have 1 side at the bottom of slot No. 1, and the other side will be at the top of slot No. 13.

In order to simplify the explanation of the method of connections between the commutator and coils we will consider each complete coil as being composed of 4 conductors, that is 2 conductors on each side of the coil. There are, therefore, in the entire armature, 4 times 50 (the number of slots) or 200 conductors in the armature. These, for convenience, are numbered as shown in Fig. 1, with the odd numbers at the bottom and the even numbers at the top of the slot. Facing the commutator end of the armature, the slots are numbered counter clockwise, and the conductors are numbered progressively in the same direction.

In order that the circuit shall not close on the finish of the first passage around the core, 1 single coil, that is 2 conductors, is left without connection to the commutator or other coils on the armature. We have, therefore, in the entire armature only 198 active conductors.

It would be well, before going further into the description, to get the meaning of the terms back, front and average pitch well defined in the mind. The back pitch of a coil is the number of conductors between the 2 sides of the single coil. It is determined by the throw of the coil, and the arrangement of the wires in the coil. Since the throw of the coils in the armature being wound is 13 slots, conductor 1, which is located at the bottom right-hand corner of slot 1, will be connected at the back end of the armature to conductor 50, which is located in the top right hand corner of slot 13. The back pitch, therefore, is 50 minus 1, or 49.

The average pitch is the total number of active conductors plus 2, divided by the number of poles. In this case the average pitch is $(198 + 2) \div 4$, or 50.

FIG. 2.—PLACING LAST COILS IN ARMATURE SLOTS

The front pitch is the number of conductors between the 2 coils, or conductors connected together by the commutator leads. This is found by subtracting the back pitch from twice the average pitch, or in this case $100 - 49 = 51$, which is the front pitch.

Winding Table

WE are now ready to make out the winding table which is done in the following manner: As explained above conductor 1 at the bottom of slot 1 is connected by the wires inside the coil on the back end of the armature to conductor 50 (1 plus the back pitch, 49), which is in the top of slot 13. Conductor 50 is in turn connected to a commutator bar which is also connected to the lead from conductor 101 (50 plus front pitch 51). This conductor is connected to conductor 150 (101 plus 49) through the wires at the back end of the armature. The commutator lead from conductor 150 is connected to bar 2, thus completing the first circuit around the armature, and lapping over 1 bar, which makes it a progressive winding.

Although we have 200 conductors on the armature core, only 198 are active, and by adding 51 to 150 to get the first conductor of the next coil, we find that this gives us 201, which is in reality conductor 3 (201 — 198).

We proceed in this manner by adding 49 and 51 alternately, and after the completion of each circuit

around the armature, subtracting 198 from the number of the conductor, until we get to the blank or unused coil, which we have chosen in this case to be that numbered 153 and connected at the back end to that numbered 2. Here we must either change our system of numbering by omitting to number the conductors which are not connected to the commutator, or leave them out of the winding diagram altogether, using those numbered 199 and 200. The latter method seems the simpler, and the table for this part of the winding is as follows, C denoting a connection to the commutator: C-149-198-C-51-100-C-151-200-C-53-102-C-155-4-C-55-104-C-157-6-C-57-106-C, etc.

Winding the Armature

THE armature is then put into the winding lathe or upon any support where it can be turned and is handy for soldering. It will be noted that the 2 sides of the coil are not of the same length, the short side

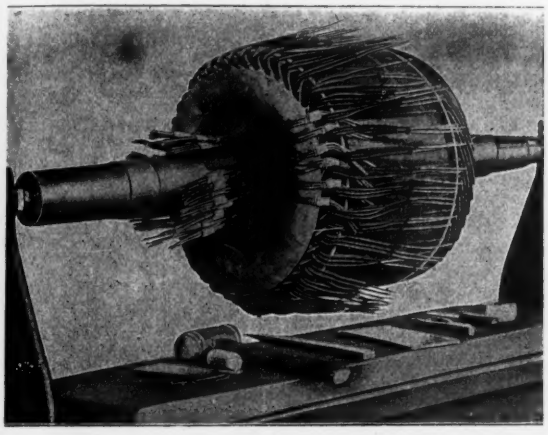


FIG. 3.—WOUND ARMATURE READY TO HAVE COMMUTATOR PUT ON SHAFT

being put into the bottom of the slot with the leads bent down and out, while the long side is for the top of the slot and the leads are bent up and back for convenience in working around the armature. Before putting the coils in the slots, cells made of paraffined paper are put into the slots to prevent the insulation of the coils from being torn while they are being placed in the slots.

After all the coils have been put into place, the insulation test should be made before proceeding with the work as this may save the trouble of tearing the entire winding out after the armature has been completed. This test may be made either with a testing transformer or by means of a voltmeter in series with the insulation; a detailed description of these methods will be given in another issue. The leads from all conductors are now numbered and tagged, and 2 and 153 are cut off close to the coil and insulated.

In nearly all cases of repair work the commutator will be in position so that the next operation will be the commutator connection. The point to be kept in mind here is that the brushes are placed at a point where short circuiting the bars with a brush will do no harm, that is, at the point where the conductors of the coil connected to the short-circuited bars are between the field poles.

For a 4-pole progressive winding only, the following rule is given for finding the commutator throw: Number of commutator bars plus 3 divided by 2, equals the commutator throw. In this case we have $(99 + 3) \div 2 = 51$. This means that one lead from coil 1 is attached to commutator bar 1, and the lead from the other side of this coil is attached to bar 51.

After all the leads from the insides of the coils have been connected to the commutator bars, a lighting-out test should be made to insure that no mistake has been made in the connection of the commutator bars. This is done by using a lamp circuit 1 wire of which has been cut and terminals soldered to the ends. By touching the disconnected lead and the proper commutator bar with the lamp terminals, if the lamp lights up, the coil is correctly connected.

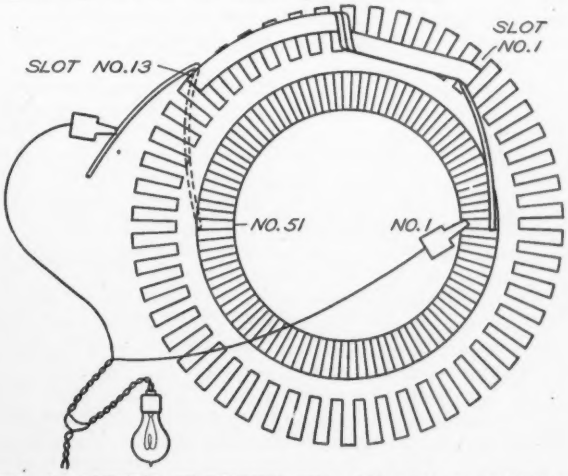


FIG. 4.—METHOD OF TESTING OUT COMMUTATOR CONNECTIONS

The upper leads from the coils are then connected to the commutator bars and soldered, after which the binding is put on the armature and the commutator turned down to remove all solder or other material which would short circuit the bars.

BOOSTERS

By R. A. Cultra

SEEING the account of Mr. McNeill's troubles with boosters in a recent issue of Practical Engineer reminds me of some of the times when my own hair stood up straight while the commutator bars were flying around the room. I have had many such troubles, but not being thoroughly conversant with the technical terms concerning these machines, I have never attempted to write about them.

The following, however, may be of some interest to men who may meet with the same experiences in the future. A booster is to boost the voltage just as the word implies. From 500 volts to 550 or 620 volts, as may be required to make up for the loss between the power house and the end of the line, due to resistance in transmission. These machines, like motors, are on the circuit and being between the motor or load and the machine, they have troubles peculiar to the position in which they are installed.

They are usually driven by an engine direct connected or a motor mounted on the same shaft. In any case the driving power must not be stopped while the booster is in circuit or it will reverse, i. e., it becomes a motor and the speed on some machines would be increased about 500 revolutions to one of the proper direction, thus they cause the wreck of the commutator.

If the booster is driven by a motor, I would suggest that the motor be wired to the bus bars solid, or with only the switch between it and the bus bar, using no fuse between the motor and the machine and relying

on the machine circuit breaker for safety in case of accident to the motor, this would put the booster out of service at the same time and save the booster, or commutator, at least.

Referring to boosters that will not boost or persist in bucking, I would suggest that the field cores be tested. There may be a demagnetized core or one may be weak or reversed in magnetism and need to be remagnetized in the proper direction. Then if it will not pick up it will be necessary to put in a new core. This core must have the same magnetic strength as the one on the opposite side or the new core may overpower the old one and the trouble still continue.

Care must also be taken that the commutator bars on the booster are not worn down too close, there being sufficient copper to carry the current at all loads. Brushes must also be set in proper position and not allowed to extend one ahead of another. The motor driving the booster must be large enough to carry the booster under all loads, even should it get 50 per cent overload. Commutators worn too close will cause bucking as well as some pyrotechnical displays should an overload suddenly be thrown on such a machine; the brushes would be burned and further damage would depend on the amount of overload and the time the machine had to carry it.

Mr. McNeill has given a good illustration of this class of machine, but having omitted the switches and circuit breaker, it is hard to tell just where the trouble originated. From his statement that the storage battery and booster were connected in series between the machine and the line, it occurs to me that the battery should be considered a generating unit by itself and so connected to the bus bars. This would not, however, leave it in parallel when running as a generator, providing the line as well as booster were receiving current through the battery from the machine. But if so connected, having a switch and circuit breaker between the battery and the line, the breaker if not stuck or set too high should have opened the circuit the instant the motor failed, thus saving the booster.

If the booster motor had been wired in solid, that is without a fuse between it and the bus bars, the source from which both the booster and the motor took their power, the breaker between the battery and bus would have saved the booster as above stated.

I once had trouble with a machine just installed; the machine was a second-hand one, bought from a dealer and repairer of dynamos and electric apparatus, guaranteed to be in first class condition. We accordingly notified the dealer and a man was sent out to look over the machine. After some conversation I learned that a new field coil had been placed on this machine, but I noticed the spool was put on with the winding coiled in the opposite direction to the other spools. Calling this man's attention to the fact, he simply stated that made no difference and returned to the shop. We needed this booster badly and the superintendent being informed of the situation, simply stated if I could use the machine to do so.

It may be said here that 2 currents traveled in opposite directions around the field core, one current killed the other and this core remained dead. Taking authority in my own hands, I removed the spool and turned it over, connecting up the leads. I started the machine, which ran all right. The next day I got telephone instructions from the dealer to change the core and try it as an experiment. I have since had similar trouble with multipolar compound wound dynamo field cores.

ENERGY OF A BOILER EXPLOSION

EXPLOSION of a boiler is not an instantaneous action, but a series of well-defined but rapidly succeeding operations. If the break occurs below the water line, it is possible that no explosion will ensue, as the situation of the break is not favorable for the production of water hammer, and the boiler will relieve itself of its pressure by the water issuing out first. But if the break be above or near the water line, the circumstances are favorable to the production of water hammer, and a violent explosion may occur.

The method of explosion, in most instances, seems to be the opening of a small hole at a point where the strength of the material is less than the stress to which it is subjected, followed by an outrush of steam or water, or both; the extension of the rupture to the adjoining parts when these parts become too weak to carry the increased stress which the break already made puts upon them, this operation being so sudden that sufficient time is not allowed for the gradual escape of the inclosed fluids; and the boiler is torn violently into pieces, and thrown far and wide by the steam generated from the liberated water.

An explosion does not follow if the parts next to the initial break possess sufficient strength, and it is probable that explosions do not occur unless the strength of the boiler is quite uniform, but less than that required to sustain the pressure. Local weakness is a safety valve that permits a rupture, and insures against a general break.

Minor defects surrounded by strong parts merely relieve the pressure; but a long seam weakened by corrosion or "burning" of the lap, a considerable area of plate thinned by corrosion or weakened by overheating, or an extended crack, may be the occasion of a disastrous explosion.

Energy in a cubic foot of highly heated water is equal to the energy in a pound of gunpowder. Most of the energy in a steam boiler under pressure is contained in the water, and only a relatively small amount of the energy in the steam. Take, for instance, the case of a horizontal tubular boiler carrying 150 lb. pressure, and having 160 cu. ft. of water space and 80 cu. ft. of steam space. The water weighs $160 \times 62.4 = 9{,}984$ lb., and the steam weighs $80 \times 0.3671 = 29.37$ lb.

The energy in each pound of water at 150 lb. pressure that would be liberated by explosion and expansion down to 212 deg. F. is 11,823.4 ft. lb., and the energy in each pound of steam at the same pressure is 134,521.3 ft. lb. The total energy in the water is therefore, $9{,}984 \times 11{,}823 = 118{,}040{,}832$ ft. lb., and the total energy in the steam is $29.37 \times 134{,}521 = 3{,}950{,}882$ ft. lb. The energy in the steam is consequently less than 4 per cent of that in the water. The water is the more dangerous content of the boiler.

The total energy in the water and steam is $118{,}040{,}832 + 3{,}950{,}882 = 121{,}991{,}714$ ft. lb. If the boiler weighs, say, 10,000 lb., and if all of this energy were expended in an explosion in projecting the boiler vertically, then, neglecting the friction of the air, the boiler would rise to a height of 12,199 ft., or over 2 miles.—Bulletin of the Fidelity and Casualty Co.

TO FIND THE HORSEPOWER of a gasoline engine, single-acting, 4-cylinder and 4-cycle, multiply the piston speed in feet per minute by the square of the cylinder diameter in inches and divide by 670.

EVERY TIME THE SAFETY VALVE blows you waste money.

THE NEW HAMILTON-CORLISS MILL ENGINE

THE FIRST ENGINE WITH NEW TYPE OF VALVE GEAR INSTALLED AT CLAIRTON, PA.

IN January, 1910, the Hooven, Owens, Rentschler Co., of Hamilton, Ohio, completed the installation of a new 42 and 78 by 60-in. engine for the Carnegie Steel Co., at Clairton, Pa., the engine starting in to drive the 21-in. mill which rolled rails on Jan. 26. It is of tandem compound condensing type, built extremely heavy and of massive design, and weighs approximately 400 tons. It runs at 85 r.p.m. on 150 lb. initial steam pressure and is rated at 4000 hp., while its maximum capacity is 6500 hp.

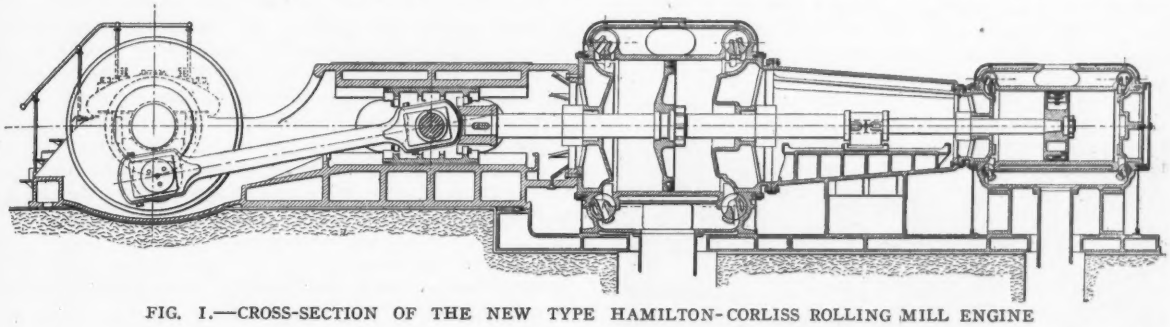


FIG. 1.—CROSS-SECTION OF THE NEW TYPE HAMILTON-CORLISS ROLLING MILL ENGINE

Of heavy duty type, the bed plate is made in 1 piece and weighs about 80 tons; while the flywheel, which is 20 ft. in diameter, made in sections, weighs 180,000 lb. In rolling mill practice the tendency is toward high rotative speed, and the change of loads is of course always violent running from nothing up to 50 and 100 per cent overload. These conditions call for the best that the engine builder can offer, both as to design and material, and any failure on the part of the engine in this class of work, which may cause a temporary shutdown, results in a heavy loss; so that the mill engineer demands a weight per horsepower for these engines not known in any other class of work.

Detailed description

THE line drawing, Fig. 1, shows an elevation in cross section of the frame, cylinder and crossheads. Figs. 2 and 3 show the engine from the crank end and from the cylinder end respectively. It will be seen from Fig. 1 that the main bearing cap projects over the jaws of the bearing forming a massive tie piece. This main bearing is 28 by 52 in., and underneath it the bed is carried down into the foundation, and re-enforced by 2 5-in. bolts, which were shrunk into position while hot. The ends of these bolts are shown in Fig. 2.

Walls of the bed which transmit force from the cylinder to the crank shaft are straight without breaks or offsets and are subjected to tensile and compressive forces only, no bending being introduced. The connecting rod is of solid end type for both crank and cross-head pins, and boxes are of steel castings with babbitt linings. The crosshead is of steel casting of box type with adjustable slippers, babbitt lined, and sliding in guides bored to receive them. The rod for the low-pressure piston is a hollow, open hearth, steel forging, and is carried on 2 crossheads, the main crosshead, and one which runs between the 2 cylinders.

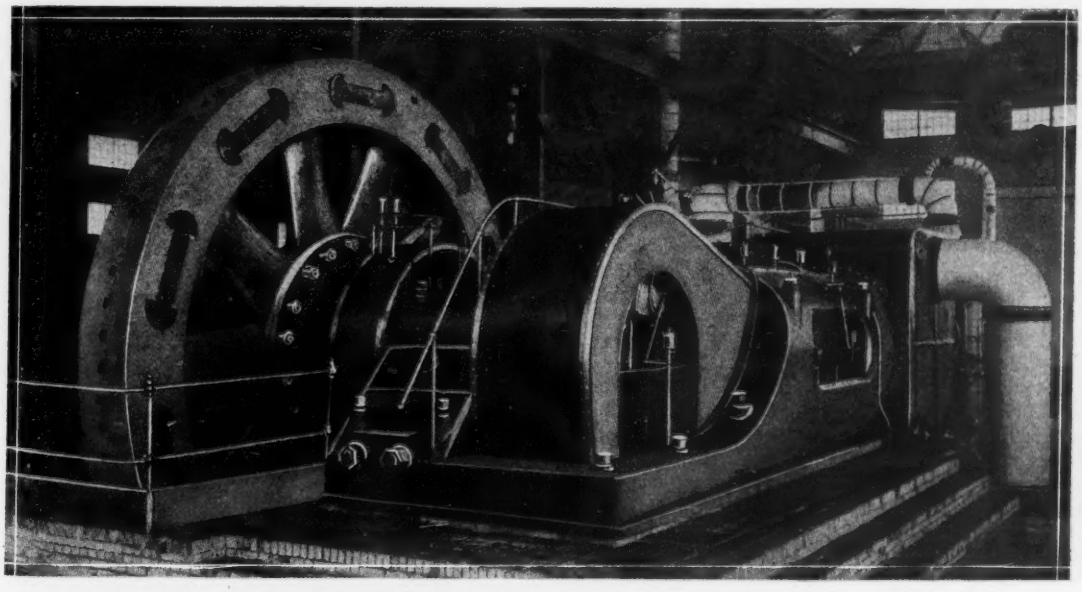


FIG. 2.—VIEW OF NEW HAMILTON-CORLISS ENGINE FROM THE CRANK END

For the low-pressure cylinder the piston is of floating, conical or umbrella type as shown in the cross section, and has 1 packing ring and a follower. The low-pressure cylinder is 1 casting with double parts in steam and exhaust passages.

Between the cylinders is a distance piece so designed that it can be easily taken out, giving access to the low-pressure cylinder. This distance piece is fastened to the cylinder heads with through bolts, and is supported on the sole plate at its center, thus giving it extra rigidity. This sole plate is massive, and carried through from the end of the bed plate under the cylinder supports and is securely keyed in place. Each cylinder has a tongue fitting into a groove in the sole plate, so that, in case it is necessary to remove the cylinder, it will come back into line when replaced. Foundation bolts are close together and carried through the full height of the bed plate, giving considerable additional stiffness to the frame. The location of the upper ends of these bolts can be seen in Fig. 2 at each side of the opening for inspecting the crosshead.

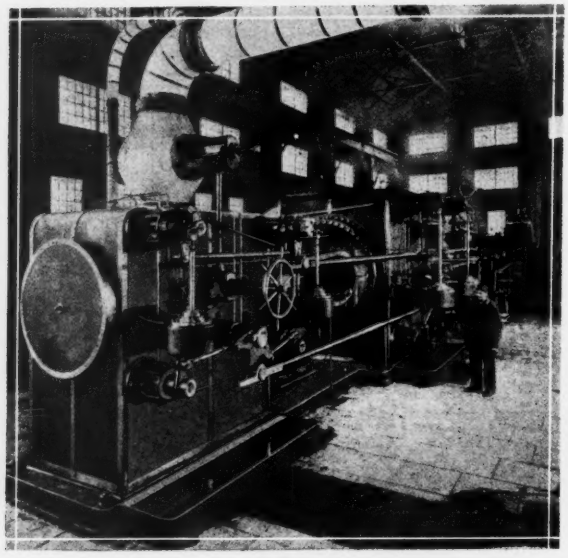


FIG. 3.—CYLINDER END AND NEW VALVE GEAR OF THE HAMILTON-CORLISS ENGINE

Valve Gear

IN Fig. 3 are shown some of the details of the patented gravity valve gear of the releasing type. In this gear no springs are employed, and it is noiseless in its action. It has also an extremely long range of cutoff and positive release, the steam valves being driven directly from the eccentric without rocker plates. Exhaust valves are driven through rocker plates on the sides of the cylinders, and the dash-pots, which are mounted on brackets bolted to the sides of the cylinders, are of a new, improved type particularly adapted for this class of work.

Lubrication of the bearings is effected by a forced feed gravity method, the oil being supplied through a Bonar automatic filtering and oiling system.

"PUT YOURSELF IN the other fellow's place is a principle which can be favorably borne in mind when dealing with subordinates. There can be no doubt that fostering a spirit of confidence between the management and subordinates tends to increase the efficiency of a plant."

"DO'S" FOR THE ENGINE ROOM

IT is said by the psychologists that to develop character instead of dwarfing it we should be positive, not negative; to make or demonstrate; "do" rather than don't. Hence the following "do's" in place of the more usual "dont's;" mostly inspired by a set of dont's for draftsmen in Machinery.

Do keep the oil holes clean.

Do be sure that there are oil grooves where needed in the boxes.

Do keep the check nuts tight on all adjustments.

Do keep the details well looked after.

Do see that you are not violating good practice, but do keep your mind open to new ideas and remember that scientific theory is not the same as "supposin'."

Do keep finished parts bright where necessary, and paint them where they ought not to have been finished.

Do allow for such clearance for running parts as is needed to be safe.

Do keep a notebook for valuable rules and data.

Do be ready to make changes when asked. They are likely to lessen your work as well as the other fellow's. Try to see the good points, too.

Do own up when you're wrong. If you only stick to when you are sure you're right, your opinion carries more weight.

Do have a key put in when power is to be carried. Set screws are untrustworthy.

Do keep in mind that a through bolt is better than a stud bolt.

Do swap knowledge with your associates. It's the kind of a trade where both are gainers.

When you get a new idea, do remember that somebody else may have had it too. It's a long time since Adam.

Do suggest new ideas and improvements frequently. They may not be adopted, but you will show that you're alive.

Do be ready to accept a compromise if you can't get ideal conditions.

Do ask the chief about matters which you think he would like to decide on.

Do use your eyes and ears—and your think machinery before you use your mouth to ask questions.

Do base your opinions on facts. Any other basis is treacherous.

Do make changes and repairs as good as the rest of the job. It saves making them twice.

Do lead ropes off the top of a drum; they work better so.

Do use parts big enough; a 0.75-in. bolt and safety is better than a 0.25-in. less metal and a smashup.

Do keep plugging faithfully whether the boss is around or not; some day you will be found at it.

Do get split pulleys for changing over old installations. It's cheaper than stripping a line of shafting.

Do remember that the fireman should grow into the chief, but he needs study outside the boiler room as a fertilizer.

Do treat the office man's knowledge with respect. He may have run a plant before now.

Do keep your papers on file. You will want those articles tomorrow or next year.

Do get the best men you can if you are chief, and keep them growing better.

Do remember that a man though full of years may be competent and valuable. If young in spirit, the added years mean added wisdom.

When the results of a calculation seem out of rea-

son, do give your common sense at least a chance; your figuring may be wrong.

Do make a job right for all possible needs, not just good enough.

Do, if you are chief, make your plant one where men will like to work. They are human and will look after their own good as well as a job.

CENTRIFUGAL PUMPS

WE have just read with interest the article on Centrifugal Pumps appearing in your March issue, in which you have incorporated an illustration and certain information regarding a De Laval 2-stage boiler-feed pump. The statements regarding the latter are correct, but, in the light of our experience in building such pumps, we believe that some of the other statements in the article should be modified.

To begin with, you say that it is "inadvisable to design a single impeller for a lift of more than 140 ft.," also that, "lifts from 140 to 150 ft. are best accomplished with centrifugal pumps by employing 2 or more impellers upon the same shaft in series."

This would seem to be contradicted by the fact that the 2-stage De Laval Pump mentioned, overcomes a head of 700 ft. with good efficiency, considering its size. In fact, we are prepared to build single-stage pumps for heads even greater than 700 ft. In the pump shown, Fig. 1, 1 stage generates only a small head, feeding a second stage in which a head of about 700 ft.

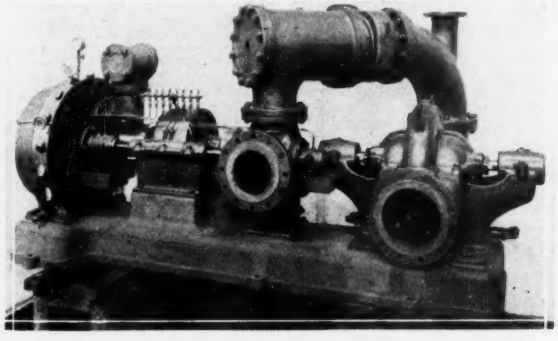


FIG. 1.—DE LAVAL 2-STAGE CENTRIFUGAL PUMP FOR 700 FT. HEAD

is generated. As you will note from the test curve, Fig. 2, the efficiency is exceptionally high.

It is true that many engineers have an impression that high head centrifugal pumps are not efficient and this impression is correct as applied to the ordinary centrifugal or "turbine" pump. Few builders use more than 125 ft. per stage, which gives about a 5-stage pump for boiler feeding purposes, as against our 2-stage pump. In a paper read recently by W. R. Wiley before the Western Society of Engineers it was stated, that "Past experience shows that it is inadvisable to design a single impeller for a lift of more than 120 ft." The real reason for this condition of affairs is that few builders know how to design efficient impellers for higher heads and, further, most of them are using a type of water packing between the discharge and suction chambers that invites a heavy loss by leakage under high pressure, which brings us to another point in your article, namely, the type of labyrinth packing which you have shown.

This style of labyrinth packing, consisting of 1 smooth surface and 1 corrugated surface running close together, will not do for high water pressures, although fairly good for steam or other expansive fluids. In the first place it allows a large amount of water to escape, and in the second, it cuts away rapidly, while at the same time the pump must run with a very small radial clearance. Our labyrinth packing is built on an entirely different principle, that is, the 2 packing rings intermesh so that the leakage passage is extremely tortuous, the water current being broken up and its velocity destroyed again and again. With this form of joint there is very little leakage, even at extremely high heads. As the joint is on the whole radial rather than axial, a centrifugal force is set up in the water between

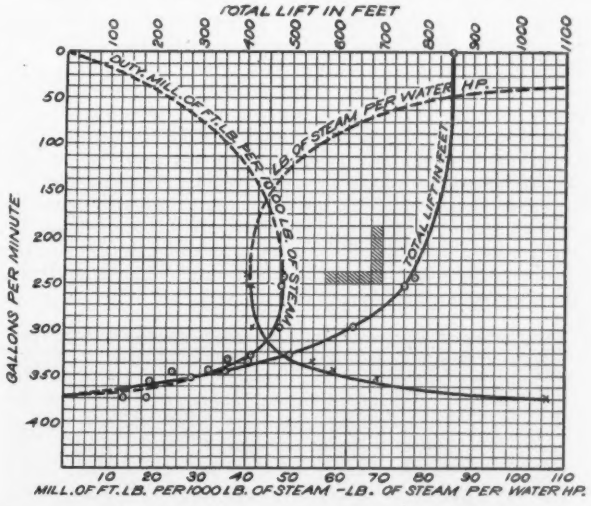

TOTAL LIFT IN FEET
100 200 300 400 500 600 700 800 900 1000 1100
0 50 100 150 200 250 300 350 400
GALLONS PER MINUTE
CURVE MILL. OF FT. LB. PER 1000 LB. OF STEAM
CURVE LB. OF STEAM PER WATER H.P.
TOTAL LIFT IN FEET
10 20 30 40 50 60 70 80 90 100 110
MILL. OF FT. LB. PER 1000 LB. OF STEAM - LB. OF STEAM PER WATER H.P.

FIG. 2.—TEST CURVE FROM DE LAVAL 2-STAGE 250-GAL-PER-MIN. PUMP

the labyrinth rings, counteracting to a certain measure the pressure producing leakage.

Your statements regarding efficiencies also fail to do full justice to the latest developments. You say, for instance, that with a 2-in. pump the efficiencies are unreliable, but a good average is 45 per cent. However, we are prepared to definitely guarantee the efficiencies of pumps of this size or of any other. Further, a De Laval 2-in. pump will regularly show on test an efficiency of about 50 per cent. To an 8-in. pump you assign an efficiency of 60 to 70 per cent. We would say rather, 72 to 75 per cent. You state that in sizes about 8-in. the efficiency does not increase rapidly; however, a 20-in. pump recently shipped by us showed an efficiency of 84 per cent on the test floor and we build quite a range of sizes showing above 80 per cent.

In view of the above, your last statement to the effect that "for use with heads exceeding 700 ft. the reciprocating pump, built for that service, gives more economical results than the centrifugal pump," should be modified, especially if over-all efficiency including gears, belts, etc., for the year around be taken into consideration.

De Laval Steam Turbine Co.,
F. W. Kennedy,
General Manager.

ON MAY 1 the Alberger Condenser Co. and the Alberger Pump Co. removed their offices to the West St. Building, 140 Cedar St., New York City, the change being necessary to secure larger quarters for the rapidly increasing business of the 2 companies.

HOW THE NEW CHIEF MADE GOOD

GETTING CASH AND LETTING CONTRACTS

By Geo. H. Wallace

DURING THE MONTH FOLLOWING the first visit of the chief engineer to the house of his employer, George Willard was a frequent caller and he and Manager John Gautelbeim became in a way quite friendly. Together they went over every detail of the proposed new power house and its equipment. On two occasions Superintendent Mather accompanied the chief and the proposed new factory was gone over thoroughly.

In addition to these evening meetings, there would be frequent meetings more or less informal at the works; sometimes in the spacious directors' room, before that august body; sometimes in the private office of the chairman of the board; sometimes in one or the other of the several engine rooms, and not infrequently out around the yards about the old factories, where, with much "pacing off," measuring and calculating, the subject was pretty well threshed out. The expenditure of approximately $1,250,000 is not, by any means, a

AND NOT INFREQUENTLY OUT AROUND THE YARDS ABOUT THE OLD FACTORIES

daily undertaking, and it was necessary that they secure the best that the requirements demand.

One morning while Fritz was regaling the chief, between his visits to the shaving bin for the purpose of keeping up "fog," with his experiences while he was an engineer "auf der Tcherman nafy" and later on the Kaiser's private yacht "Hohenzollern," the desk 'phone rang sharply.

"Yes?"

"This is Mr. Gautelbeim. There will be a meeting of the Board at 3 o'clock this afternoon when the subject of the new power house and factory will be acted upon. Will you be ready by that time?"

"Ready now," Fritz heard the chief reply and he began to wonder what it was all about, and as he wielded the shaving shovel again, his thoughts conjured up a dozen reasons why the chief had expressed such immediate willingness to do something or other right off the reel.

"All right, Mr. Willard, we will look for you. Now make it strong, Willard; make it strong."

"Very well, sir."

Willard took out a roll of drawings over which he had spent many hours during the past weeks, not a few of them being evenings, which had lasted until wee morning. Stepping to a long cord that hung from the ceiling he blew the signal whistle 3 shrill blasts and soon the superintendent entered the chief's little office.

Over every phase of the proposed improvements they went in a general way and found that they could not improve them or suggest anything new. They examined every detail of their preliminary specifications for both the factory and the power plant, but changed not a word. When the noon whistle blew, Willard rolled up the plans and they left the room.

Fritz gave the greasy hand wheel on the throttle valve a vigorous twist which sent it spinning almost to its seat and while the engine was slowing down he went around closing oilcups and feeling the bearings.

"Py chimminy Christmas, Ay bet doze 2 fellers vos going ofer daes afternoon to show ole Yon a trick mit a hole in it. Dot chiefs vots all vool und a yard vide, varranted not to wear, tear, rip, ravel, or run down at der heel, und Ay bets dot he make Yon Gautelbeim eat out of his hand und yump ofer chairs like

THE DESK 'PHONE RANG SHARPLY

Hagenbach's lions in Berlin. Hoch! der Kaiser! Hoch! der President!" and Fritz also went to his happy home for dinner.

At 3 o'clock the several members of the Board of Directors seated themselves about the mahogany table at the head of which sat John Gautelbeim. As a matter of form he stated the object of the meeting briefly, for all present were more or less familiar with the proposed factory extensions and the new power house. John lit a cigar from a box on the table, puffed it vigorously for a moment and solemnly, pleasantly and firmly announced:

'The Board of Directors will be in order."

Then John arose, jerked vigorously at his vest several times and clearing his throat said: "Gentlemen, it is with great pleasure that I announce that we have arrived at that point of our existence when it is absolutely necessary that we branch off on a new road and 'burn our bridges behind us,' so to speak. The present state of our trade is such that the future is a certainty.

"Two years ago, and even more recently, we had all the available space, both at our factory and at our foreign and home agencies pretty well filled with unsalable machinery and supplies simply because they were not made by skilled mechanics and we didn't pay enough to get anything but the floating element—the payday to payday kind.

"It is not necessary for me to acquaint this board with the reasons why we are regaining all that trade, most of which in South American ports went to the English and German manufacturers. There is a reason. To express it frankly, we didn't know our busi-

ness. While not a Missouri concern, we had to be shown," at which the dignified board smiled broadly.

"But we were shown the error of our ways by 2 men, and it is to these men that we owe our success to-day; and to-day I have requested their presence here that we may have them explain to us their proposed extensions to the factory and also the new power house. Johnnie," to the office boy who appeared at the ring of the bell, "ask Mr. Mather and Mr. Willard to please step this way."

As they entered the room, it was not hard to see that the board was already willing to hear and see what they had to say and show. Taking a large drawing from the roll, Mr. Mather had first innings, and spreading the paper on the table, briefly stated as well as became a man of such few words, the various features of the new factory and its probable cost.

Then the chief engineer pushed the curling brown locks from his forehead and explained his drawings as he had to Chairman Gautelbeim on several occasions. He had the peculiar and enviable faculty of carrying his hearers with him, and it was not long before the face of each listener showed a determination to take up with the entire proposition.

The idea of a tunnel as a means of heat, light and power distribution struck the fancy of the board at once, and they were much enthused by the chief's words in favor of it. Through it all the chairman sat back and blew smoke rings at the chandelier. It was useless for him to interrupt, for Willard was pounding every detail into their heads so thoroughly that they could not but see the absolute necessity of an entire new factory.

When the 2 men had retired, the chairman said:

"Gentlemen, what is your pleasure?"

"Mr. Chairman," said E. P. Baum, "I move you that the capital stock of this company be increased from $1,500,000 to $3,000,000, fully paid up."

The motion was duly seconded, put, and carried unanimously, and after a few brief details the board of directors adjourned. John rushed over to Willard's office where he found the chief and the superintendent busily figuring.

"Well, gentlemen," said he pleasantly as he rushed in upon them, "go ahead with your factory and power house and send the bills to me. We voted to-day to give you both a raise; and we trust that you can carry everything to completion at an early date."

They talked at length on the subject and finally Mr. Gautelbeim returned to his office.

The chief sketched a brief letter to several boiler manufacturers requesting bids to furnish a certain number of boiler horsepower running well up to the 2500 mark. One clause was very peculiar. It read: "Two boilers must be delivered to the railroad for transportation by the manufacturer in seventy working days from signing contract, complete with all appliances and fixtures as specified in the contract, and on failing to do so the manufacturer will forfeit $25 from the contract price of the boilers for each day's delay, and the manufacturer will file a bond or deposit a certified check with the purchaser for One Thousand Dollars ($1,000) to insure prompt delivery of the boilers."

"There," said Willard as he laid down his pencil, "I guess that will hold them for awhile."

"Why this peculiar clause?" said Mather.

"Why? Well I had one experience once and that's enough. I was quite young then and the boss bought a boiler. The manufacturer, whose works were in a nearby city, promised by all that was high and holy to have the boiler on the grounds in 60 days. At the end of 70 days I skipped over there and made a 'holler' for our boiler.

"'Come here young man,' said a dignified salesman from their office as he pointed to a flat car in the yard, loaded with boiler plates, 'there's the "junk" for your boiler and you don't get it till its made. See!' and I saw.

"Well," continued Willard, "there I was Oct. 15 and winter coming on, with an old boiler that held in like a flour sieve, and threatening to 'let go' every day. No, sir! I don't get caught again. We will not be ready for the first 2 boilers before 70 days, and there is no object in offering a bonus for quicker delivery. But we do want them in 70 days, and if they are not shipped then there is going to be something doing."

"Yah! you chust bets dere vos been somethings doing," thought Fritz, who was a silent but interested listener, "doze fellers petter look ouf von, two, tree time und not monkey mit der pand vagon. Dot Villard vos condensed dynamite soup ven he gets he's Irish oop," and Fritz went back and oiled up again.

Writing the names of the several firms whose boilers found favor in his eyes, he pinned it to the letter and later handed it to the stenographer to be written and despatched. Then he took up the question of the stack, the new boiler and engine room, and the digging of the cellar. In the course of a week Willard was a busy man, and he often had several salesmen on the waiting list at his little office in Fritz's engine room.

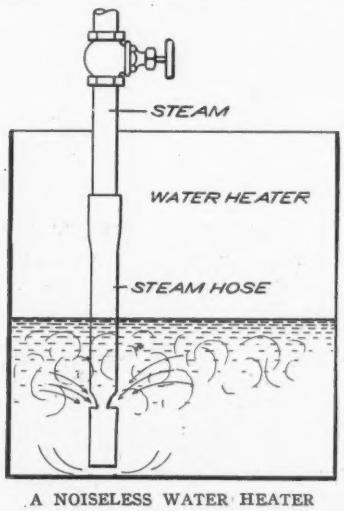
Frequently they whiled away the time of waiting talking with Fritz, who, while he talked a lot, said but little, for he had caught the spirit of his chief and kept his own counsel. But many were the oil agent cigars that Fritz struggled over, coughed over and swore at, said cigars being presented perhaps with the hope that Fritz would intercede with the chief in behalf of the giver.

(To be continued.)

A NOISELESS HEATER

I HAVE a noiseless water heater that is a good deal easier and quicker to make than any other I have ever seen.

Take a piece of old steam hose 1.5 or 2 ft. long



A NOISELESS WATER HEATER

and cut out about 6 in. from 1 end, as shown in the sketch, and stick the other end on the steam pipe.

Frank Gartman, Mechanical Digest.

KINKS FOR THE REFRIGERATING PLANT*

By William Nottberg

Crank Pin Cracked

ONE DAY in a plant of 5 machines, running at 50 r.p.m., the crank shaft in a vertical double acting machine began to heat up. It was loosened up a little, but knocked so badly that we concluded to take the machine apart, so we shut off all the expansion valves, turned off steam, and took off the connecting rod.

All the brasses were bright and the pin, but there was a crack in the fillet near one crank nearly around the pin. And this in June! What was to be done?

Well, we speeded the remaining 4 machines up to 60 r.p.m. and nearly kept up the capacity of the plant,

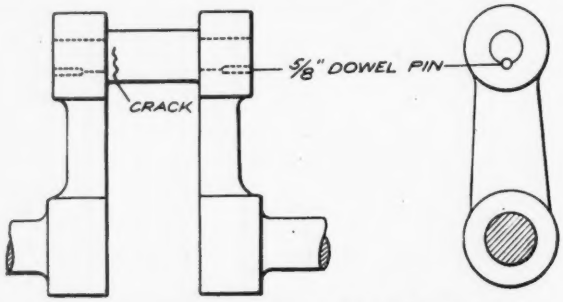


FIG. 1.—CRACKED CRANKPIN AND THE REMEDY

and they made music to my ears as I sat on the porch several blocks away from the plant. We soon had the shaft out of the machine and in the shop, and made a repair as in Fig. 1. The crack shows where the trouble was. We cut off the pin and bored out the cheeks 1 in. smaller than the diameter of the pin; then we made a new pin and, heating the cheeks, shrunk in the ends of the pin and put in the dowels, and riveted the ends over.

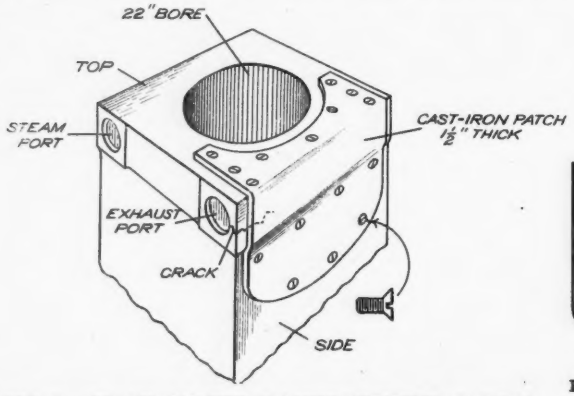


FIG. 2.—REPAIR ON THE CRACKED CYLINDER CASTING

It was a fine job and the machine was shut down only 3 days; and by the speeding up, only 5 tons a day was lost in a plant of 75 tons capacity. After the machine was running again, I did not slack down the speed until we had made up the loss which was 4 days.

The shaft was as good as new, cost a great deal less and has been running for 20 yr.

*Abstract of a paper read before the Western Ice Manufacturers' Association.

Top Cylinder Head Broken

ANOTHER pleasant job was when the piston rod broke and went through the top cylinder head of the vertical ice machine, cracking the cast-iron cylinder through the valve port. It was a Corliss, and at that time there was no autogenous welding system for quick repair in place. We could buy a new steam cylinder,—but we didn't.

We took a pattern of the outside of the cylinder casting and made a casting of the shape shown in Fig. 2; then drew the crack together as well as possible and screwed the patch home with iron cement under it. It was a good job and in 4 days we were going again.

Beating a Boiler Bag

ONE day a fellow engineer sent for me, and when I arrived he was in a cold sweat running his machine at half speed with the fire pulled from one of his horizontal tubular boilers. We attached a candle to the end of a stick, and found that there was a bag hanging down 1½ in. over the furnace.

We kept cold air rushing through the tubes, and water in and out of the boiler, so as to cool her as quickly and evenly as possible, and shortly were able to take off the front manhead. The bag was as shown in Fig. 3.

In the center it looked as if the shell was much thinner than in the rest of the boiler, and the engineer wanted to send for a boiler maker and have a piece cut out and patch put on. The owner asked me how long it would take to get the plant running and I said 2 to 3 hr.

Drilling a hole in the center of the bag, we found that the shell was 5/16 in. thick at that point, much stronger than the riveted joints. So we put a rivet in the hole, heated the bag to a cherry red, and drove it back into place just as nice as you could wish. The boiler went back into service by 6 o'clock, and is running yet, though the repair was made some 4 yr. ago.

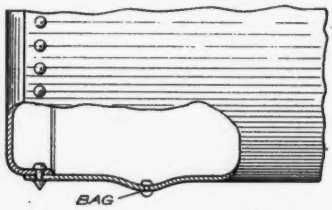


FIG. 3.—THE BAG IN THE BOILER

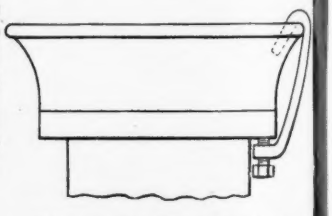


FIG. 4.—CLAMPS USED ON THE COMPRESSOR HEAD

Compressor Lost Its Head

WHAT do you think of a compressor doing that, and in August, too? Just because a valve broke and fell into the compressor. The unfortunate engineer called me up and asked what to do, and I found on arriving at the plant that the studs had broken and pulled out, so we had no time to lose.

How should we hold down the compressor head?

Clamps! that's the solution; and they were made as shown in Fig. 4. These were of flat iron 2 by ¾ in., tapped for ¾-in. cap screws. The holes in the head were closed with cap screws, and a rubber and

iron washer put under the head. The clamps were pulled down and the compressor set going again.

Ringing a Piston

ANOTHER time a 300-ton machine, driven by a horizontal steam engine had a noise on the forward stroke like water hammer. It stopped when the machine was speeded up but commenced when the speed was reduced again.

We took diagrams on fast speed and slow speed; in fact on every speed, and I don't know what we didn't do. We spent all one day indicating that engine, then concluded to take off the cylinder head, although that meant the loss of a whole day's ice.

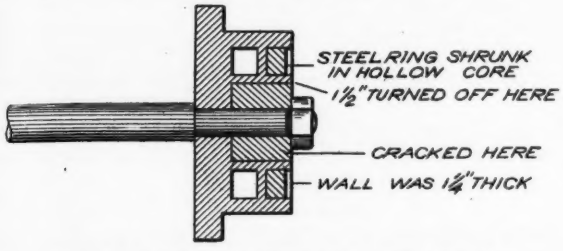


FIG. 5.—STEEL RING SHRUNK ON THE PISTON

The piston looked all right, but we pulled it apart and found a crack in the bore, but not all the way through and the factory 2200 miles away. Three to 4 days to get a new piston if the casting and the luck were good.

This is the way we did it. We took out the piston and rod, leaving them together, and took them to a machine shop. One and one-half inch was turned off, and a perfectly fitted steel ring 1½ in. thick by 6½ in. wide was shrunk into and around the hub as shown in Fig. 5. It was a day's work, and the piston is running this minute.

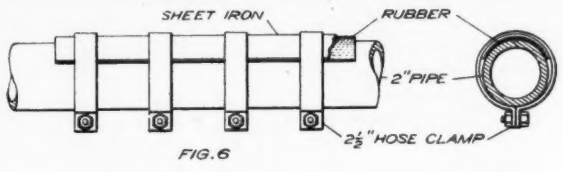


FIG. 6

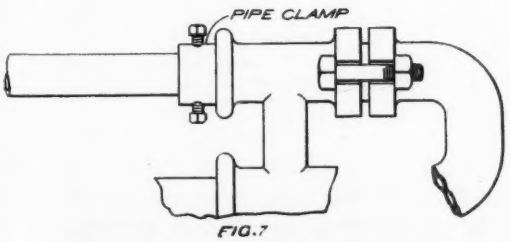


FIG. 7

FIG. 6.—HOSE CLAMPS FOR A CONDENSER TUBE
FIG. 7.—"CLIMAX" JOINT CLAMP FOR AN EMERGENCY REPAIR

Burst Condenser Pipe

ON another occasion a condenser pipe burst, and though the top and bottom valves were shut as quickly as possible, we were obliged to let the ammonia leak out from that section. Quick repair? Yes, with a piece of pure gum rubber and a piece of sheet iron, each about 2 in. longer than the split, fastened against the tube with hay wire and then hose clamps. All done in about an hour, and it held for the rest of the season. Figure 6 shows the idea.

Leak Around a Fitting

IN a double pipe condenser, there came a leak just back of a fitting, and the ever helpful Climax Joint Clamps were put over the leak and against the fitting. The stunt is shown in Fig. 7, and I believe that the clamp was never taken off.

Bran in the Tank

OF course you all know that bran or cement in the brine will quickly stop a leak in the tank; but be sure that you stop the circulating pump during the process and for 5 hr. after or you may stop the valves in the pump.

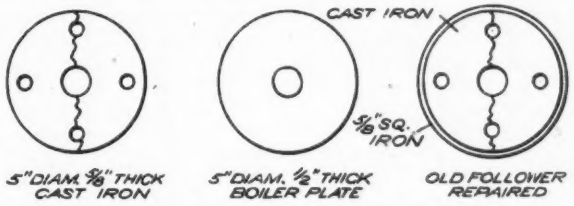


FIG. 8.—PUMP FOLLOWER MAKSHIFT

Pump Repairs

FOR a friend at one time who had a brass lined pump that had to be repacked about every day, I split the liner which was nearly worn through at the bottom, and we put in real hard hydraulic packing about ⅛ in. larger in size than that used in the liner, and ran without the lining. I think that the liner was never put in again.

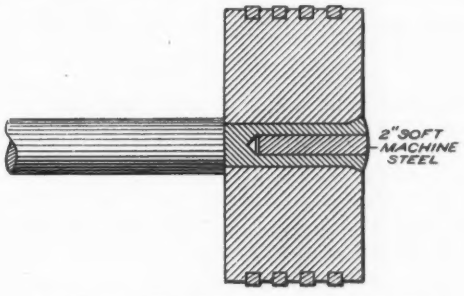


FIG. 9.—TIGHTENING FOR A LOOSE PISTON

At another plant the unlucky engineer reported that the follower of the piston of a duplex water supply pump had broken as shown in Fig. 8; without the pump the plant could not run a minute, so there was no time to wait for a new piston follower, or a new casting.

Boiler plate ½ in. thick was brought into use and a follower made from that. The next day we turned the old follower plate down and shrunk a ⅝-in. square iron ring on it so that we now have a spare part,—but of course, we have had no occasion to use it in the 2 yr. since the repair was made.

By the way, have you ever noticed that the duplicate part that you have on hand, you never have need to use?

Loose Piston

IN a double acting 250-ton gas refrigerating machine the piston came loose on the rod. It made a nice tune in the machine on the up stroke; it seemed as if the tune was first in the crank and then in the bottom

head, everywhere and nowhere. I concluded that, if the piston was not loose, a piece of metal must have lodged in the bottom of the cylinder so that the piston touched it every time on passing the bottom center.

Well, I resolved that the piston had to come out, and out it came. It was of the type that is shrunk on and then riveted, 20 in. in diameter with a 4-in. piston rod with a shoulder as shown in Fig. 9. I took it to the shop, bored a 1 31/32-in. hole in the center of the rod and 10 in. deep, and into this hole we pressed, or rather drove, a piece of soft 2-in. machine steel with a 6-in. ram, until we could drive no more.

We then riveted a new head on the rod by taking a shallow cut off the piston for ½ in. around the rod;

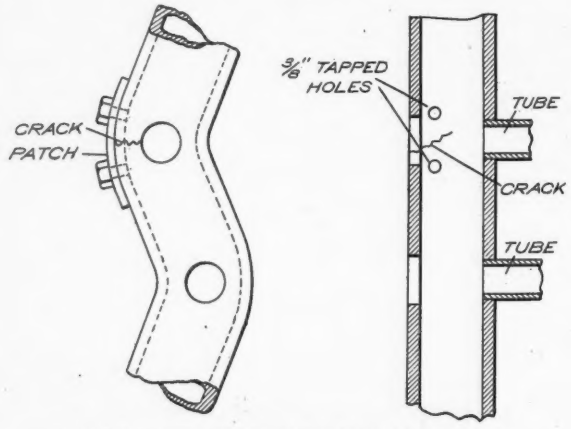


FIG. 10.—THE CRACKED HEADER MADE GOOD

and the piston is running 24 hr. of every day in the week.

Boiler Header Crack

TWO boilers in an ice plant were just large enough to operate the plant when running at full capacity. As is always the case when things are forced to the limit, something had to happen, and in this case it was a crack in a cast-iron header at the front of the boiler, so that the water and steam were blowing out. Everybody was scared for fear that the header might let

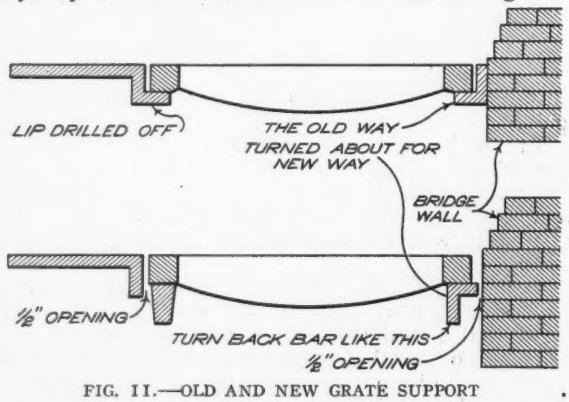


FIG. 11.—OLD AND NEW GRATE SUPPORT

go at any time, when I was called to the scene by my fellow engineer, and asked what I could do. He was frantic, of course, and said, "if I have to shut down that boiler, I lose half the capacity of my plant."

We pulled the fire, slacked the ice machine down to half speed, put the pullers on half rations both of work and pay, and let the water out of the boiler when it had cooled down enough. The crack in the header was found as in Fig. 10.

Now the nearest place to get a new header was Chicago, and it would take 4 to 5 days at best. Nothing beats trying, so we drilled 2 ⅜-in. holes, one at each side of and about 2 in. from the end of the crack and tapped them for 7/16-in. cap screws. We then took a piece of steel ¼ in. thick and 1¼ in. wide and heated it, then hammered it until it fitted over the crack like a patch of rubber would have fitted by pressing against it.

We then marked off the holes, but drilled them 1/16 in. closer than the holes in the header, and filled the crack with "Leak-No," also smeared a little, about the thickness of a coat of paint over the place that the patch was to occupy, which had previously been well cleaned off.

The patch was then made red hot and laid over the crack, it was expanded enough to admit both cap screws, and was quickly put into place and screwed up tight. After it was cooled and the boiler filled to the proper gage, there was no leak at the crack, so the boiler was fired up and put into service at full capacity after a shut down of only 5 hr.

Grates Down

ANOTHER time in the middle of the summer some 10 yr. ago, the grates fell out of a boiler. As I had all the brickwork overhauled the previous winter, I could not account for this, but on examination, I

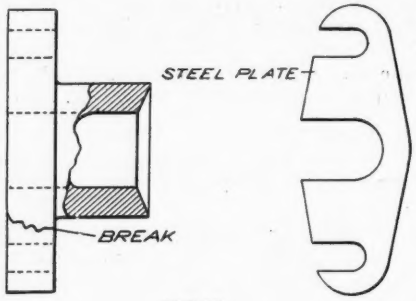


FIG.12

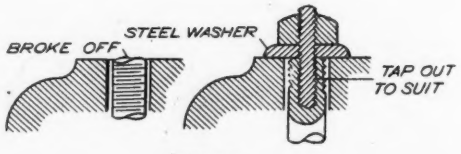


FIG.13

FIG. 12.—TO HOLD A BROKEN PUMP GLAND
FIG. 13.—EXTENDING A BROKEN FOUNDATION BOLT

found that the front of the boiler had bulged. Well I knew that I had allowed for the expansion of the grates, so I concluded that I could spare the boiler long enough to find out the cause and provide a remedy.

I found that the grates which had not fallen were wedged so tight that they had to be driven out, with ash and cinder at the ends, and the cleaning hoe had forced more in when the fires were cleaned. The bars were supported as in Fig. 11.

I drilled off the lip of the front support for the grates and put a straight iron bar under, running the full length of the boilers. By using a center prop, I turned the back support around as shown and allowed a space of ½ in. between bridge wall and grates, and forced the boiler fronts back into place. We fixed all 8 boilers in this way,—and that's the end of that.

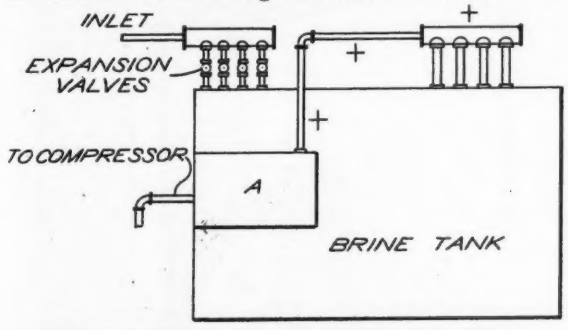
Bolts and Glands

MANY engineers have put steel plates in front of glands when some overzealous helper has screwed up too hard on the bolts and broken the gland flange as shown in Fig. 12. Probably some have put an extension on a broken foundation bolt which had parted just below the bed plate as shown in Fig. 13. In this case the 1½-in. bolt broke as seen in the figure, and it was not safe to let the extra strain come on the rest of the bolts, as nobody could tell when they might give way. We drilled and tapped the end of the bolt for a 1-in. bolt about 2½ in. deep, then made a piece of 1-in. machine steel into the form of a stud bolt put a heavy steel washer on top and tightened up. When we have time we will make a nut for the 1-in. bolt the same dimensions as that for a 1½-in. bolt, and then take out the washer. We are secure to the strength of a 1-in. bolt.

FROSTING OF REFRIGERATING PIPES

I AM in charge of a 5-ton ice machine, ammonia compression system; the engine runs at 70 r.p.m. I usually carry 25 lb. low pressure and from 180 to 225 lb. high pressure. Temperature of the brine tank is about 15 deg. The accompanying sketch shows the pipe connections. The temperature of the water in tank A is from 88 to 90 deg. as it comes from the filters. As we use the cooling water over and over again it runs pretty high in temperature, usually about 110 to 130 deg. on a hot day.

The ice engineer here insists that no frost should be on the pipe marked X, or should not extend further than the expansion valves. As the pipes after leaving the brine tank run through the water tank it seems to



PIPE CONNECTIONS IN REFRIGERATION SYSTEM

me that it should frost over as far as the point where the pipe leaves the tank A, for that water is at about 88 deg. and will have to be brought down in the brine tank to 15 deg.

Having explained the working conditions I would like to know how far the frost should extend, and what would be the proper low pressure in the coils in the brine tank. At present I carry 25 to 30 lb., as the coils to tank A will not frost under 25 lb. pressure at the rate we pull ice, 15 to 18 300-lb. cakes during a 12-hr. shift, with a brine-tank capacity of 84 cans. M. W. B.

A. First, keep the high pressure side more regular and not to exceed 200 lb., because the flow of liquid anhydrous through the expansion valve is then easily regulated. Second, increase of pressure increases heat and decreases the amount of heat that the expanded gas can abstract from the brine, therefore the low pressure should not exceed 20 lb.

The expansion valve should be so regulated that a white frost beyond the expansion valve is just noticeable; at this point the expanded gas will do its best work from an economical standpoint; the return gas pipe, entering the forecooler or tank A, will then be cold but not frosted; the brine, however, will be lower in temperature.

The writer is familiar with a large plant delivering full capacity while operated on the above plan. The brine averaging 11 deg. above zero and the can water 78 to 80 deg. It is false economy to use water on the condensing coils at 130 deg., as it is clear that the liquid ammonia cannot be cooler than the condensing water, and seldom as cool.

When one takes into consideration the fact that each 10-deg. increase in temperature of the liquid ammonia decreases its efficiency to absorb heat from the brine about 7 per cent, it evidently would be advisable to adopt some method of cooling the water or let it waste. W. S. Luckenbach.

SOLDERS FOR VARIOUS METALS

SOLDERING is divided into two classes, namely, hard and soft soldering. Ordinarily soldering with a heated copper bit employs "soft solders" —alloys of tin, lead, etc., which melt at comparatively low heats. The use of the blowpipe makes possible the employment of "hard solders" which are alloys of silver, copper, zinc, etc., and melt at a very much higher temperature than the soft solders. The hard

SOFT AND HARD SOLDERS FOR VARIOUS METALS

Metal to be Soldered	Flux	Soft Solder		
		Tin	Lead	Other Constituents
Aluminum	Stearin	70	....	Z*25 A* 3 P* 2
Brass	Chloride of zinc, rosin, or chloride of ammonia	66	34	.....
Gunmetal		63	37	.....
Copper		60	40	.....
Lead	Tallow or rosin	33	67	.....
Block tin	Chloride of zinc	99	1	.....
Tinned steel	Chlor. of zinc or rosin	64	36	.....
Galvanized steel	Hydrochloric acid	58	42	.....
Zinc	Hydrochloric acid	55	45	.....
Pewter	Gallipoli oil	25	25	B*50
Iron and steel	Chloride of ammonia	50	50	.....
Gold	Chloride of zinc	67	33	.....
Silver	Chloride of zinc	67	33	.....
Bismuth	Chloride of zinc	33	33	B 34

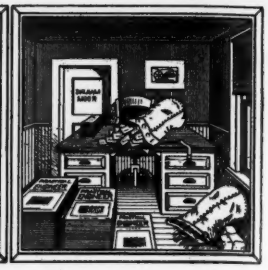
* Z = zinc A = aluminum P = phosphor tin B = bismuth

Metal to be Soldered	Flux	Hard Solder			
		Copper	Zinc	Silver	Gold
Brass, soft	Borax	22	78	.....	.....
Brass, hard	Borax	45	55	.....	.....
Copper	Borax	50	50	.....	.....
Gold	Borax	22	.....	11	67
Silver	Borax	20	10	70	.....
Cast iron	Cuprous oxide	55	45	.....	.....
Iron and steel	Borax	64	36	.....	.....

soldering of copper, iron, etc., is generally known as brazing, and the solder as spelter. It must be borne in mind that both soft and hard solders deteriorate with age, if kept for a long time in a damp atmosphere. For electrical work, ingredients such as mixtures of vaseline, rosin, glycerine and chloride of zinc are used as non-corrosive-fluxes. The accompanying table gives the composition of both soft and hard solders that are suitable for various metals. E. Eyles.—Machinery. Manchester, Eng.

Letters From Engineers

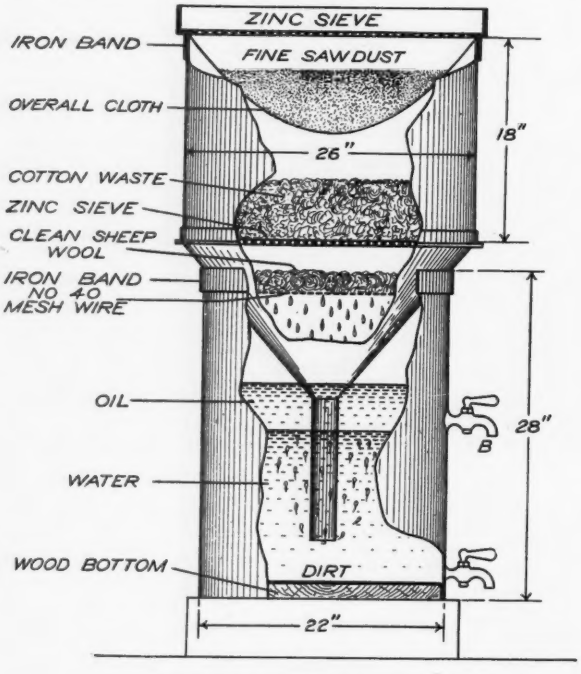
Tell us about your new kinks and new thinks. Rough sketches are always helpful; we make the drawings. Cash paid for accepted contributions.



A HOME-MADE OIL FILTER

IN making the oil filter shown in the illustration, we used galvanized sheet iron for the outside, and funnel; inside were placed sieves, waste and wool as seen in the sketch. We used a common 0.5-in. plug faucet with a lever handle placed 3 in. from the bottom of the tank, and another faucet like it 21 in. from the bottom of the tank, as seen at B, from which is drawn the filtered oil.

We made an oil receiver and filter chamber of cone shape with a hopper at the top and a 3-in. tube running to within 2 in. of the bottom of the tank. We soldered No. 40 mash wire screen and also one zinc sieve to the sides. The top has a rim to form a hopper and a zinc sieve is soldered to this. The overall cloth bag is made and filled with clean saw dust, and the second sieve is covered, 4 or 5 in.



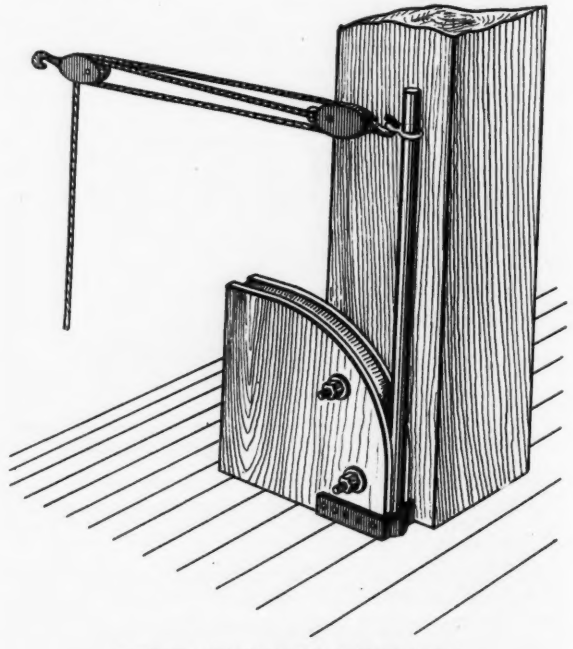
HOME MADE OIL FILTER

deep, with clean waste. The No. 40 mesh sieve is filled with good clean sheep's wool. This wool drains easier than cotton waste on a fine sieve and will not clog or pack the sieve shut and prevent draining.

We put in water, filling the receiver to within 3 in. of the upper faucet, which floats the good oil to the top when it is ready to use. The first zinc sieve gathers the coarse particles, the saw dust in the bag catches the fine grit and dirt, the cotton waste separates any stray saw dust that might get through the cloth, the bottom No. 40 mesh sieve with sheep's wool removes all grit and fine dirt. After passing through the top sections the oil is forced by pressure through the tube and escapes at the bottom. The oil floats to the surface of the water, free from all gritty impurities. The tank has a wooden bottom and galvanized sheet-iron cover, so it can be moved, and kept in shape. The top of each part is bound with a hoop 0.25 by 2 in., to keep the tank round. Before we made the filter we were using 50 gal. of oil, after the filter was made and in operation we used only 20 gal. of fresh oil every month. J. Laffelmacher.

HOW TO BEND COPPER PIPE

IT is often needful to bend large sizes of copper pipe in paper mills where wrought iron cannot be used on account of acids used in the manufacture of sulphite pulp. The commercial fittings, such as ells, tees,



METHOD OF BENDING COPPER PIPES

etc., are not suitable because any impediment to the flow of acid, as the rough edges and threads of the pipes and fittings, cause a deposit which rapidly eats through the metal and ruins it in a short time. Long easy bends free from all obstructions are best and cheapest in the end.

The following method of bending copper pipe of standard iron size was used successfully. Of course, practice and care in manipulation give more perfect results. A post or column within the building is

selected and to it is bolted a true plate sawed to the exact curve of the circle desired. The edge of this wooden block is hollowed, so that it conforms perfectly to the outside circumference of the pipe. This hollowing of the block prevents the pipe flattening on the 2 sides as strain is put on the tackle. The pipe is placed in a vertical position and at the lower end a strong iron bar is bolted to the true plate to hold the front of the pipe rigidly.

Hot sand is prepared, generally on a large sheet of iron nearby, and when it "smokes" it is poured into the pipe, filling it full and a wooden plug is driven into the end of the pipe sealing the sand perfectly.

The block and tackle is attached to the pipe at its upper end and 4 or 5 men begin to pull it over the curve, as it bends another workman gently strikes the curving surface with a hammer to assist the metal to take shape. The pull must be applied evenly or kinks will result.

Much better results can be secured if the pipe is heated before putting in the hot sand but it is very difficult to handle a large pipe in this condition. With careful work quite perfect and graceful curves can be made.

R. H. Brown.

BAG IN THE BOILER

IN THE February issue, on page 145, Hays Skaton asked what caused the bag in the boiler described. As there was an inexperienced man in charge of the boiler, this is rather a hard question to answer. It may be that in blowing down he allowed the water to get below the proper level, and having a hot fire under the boiler, this would loosen the scale on the flues, which would drop to the bottom of the boiler in a heap, and this might cause a bag with a hot fire under the boiler.

If the water was fed into the boiler at the back end, its velocity upon entering would form a whirlpool where the mud and scale would settle when cooling, and then, by crowding the fire when raising steam, this sediment would form an insulator which would cause a bag in the boiler.

The bag may be caused by having the fire door open too long when cleaning the fire. If the boiler is dirty, when you open the fire door the cool air chills the plate as the mud settled at the bottom does not allow the water to keep it hot, and as is generally the case, the fire is crowded again until the steam is at the proper pressure and the fire in good shape.

It is my opinion that any one of these 3 causes may have been the case with the boiler in question.

A. H. Elliott.

STEAM PIPE VIBRATION

IN complying with the request of K. W. in Practical Engineer for March, page 204, I will say that there are several ways to overcome the vibration in steam pipes, which should properly be considered at the time the system is designed. After the design is a reality, the next best thing to do for safety is to apply anchor rods.

The design of the system in question, should have been anchored 4 different ways which, if properly done, would have saved the wrecking of the throttle.

In designing pipe systems, especially for automatic engines, a much larger pipe should be used than is customary for the reason that the friction of steam through the pipe is thus reduced, likewise the pulsation of the pressure at the instant of opening and closing the engine admission valves, making the pressure more uniform from the boiler to the engine.

High velocity of steam through a pipe from the boiler to the engine tends considerably to reduce the pressure at the engine. Then the sudden closing of the admission valve causes the press to pulsate; the impact of the steam acts upon cross lines of the system and causes vibration of the pipe.

Vibration of steam pipes has been almost entirely eliminated, by changing the engine speed, thus throwing the opening and closing of the admission valves out of unison with the natural vibration of the pipe. But there are few plants where the latter can be done without incurring great expense.

The use of long bends in steam pipes to engines will greatly reduce the liability of vibration of the pipe.

S. A. Smith.

FRESH AIR HOOD

IN the accompanying illustration is shown a method I have used to supply fresh air for breathing while working around blast furnaces. What I used was simply an empty cement bag with a ¾-in. hose connection from the blowing engines. This was provided with 2

FRESH AIR HOOD

holes about 1.5 in. in diameter to see through and also to give an outlet for the air. The bag is tied about the neck with a string.

I have been in gas where I could not see objects 20 ft. away. The method is not patented and you are invited to try it when you have any occasion to do so.

James G. Penny.

CATALOG LIBRARY

AS A constant reader of the Practical Engineer for a number of years past, I take a deep interest in the contents of each number as it arrives.

I note in the March issue the subject, "Getting a Library of Technical Information Without Cost" and have something to say on this subject that may be of value to my colleagues. A number of years ago I received a catalog through some unknown source, I read it through and found that it contained some valuable information.

At about the same time I subscribed for a monthly magazine which was read as usual and at the same time I read the advertisements and saw that there were some firms that gave catalogs away for the asking; these contained valuable information concerning different products which each manufactured.

A thought struck me that as these catalogs were free for the asking, I was as much entitled to receive them as was the master mechanic under whom I was working at the time, and consequently I sent out some

letters asking for copies of catalogs. With the next mail or 2 I received the catalogs which contained valuable information about this or that which was used in the shop, power house, round house and in fact every branch of the machinist's business.

These catalogs I preserved and took good care of, consequently about 3 weeks ago as I was ready to move to another town, I found it necessary to have a large box in which to put them. After I was settled in my new home I found it necessary to add to my library 2 more sections of bookcase.

Having a typewriter at hand I listed these catalogs alphabetically and after I was finished counted over the list and found that I had 150 catalogs of every description, steam engines, gas engines, wood and metal working machinery, power plant appliances, electrical machinery and in fact of almost everything sold.

I divided these into 3 different classes as follows: 1st, machinery with the exception of electrical; 2d, electrical machinery and supplies; 3d, miscellaneous and everything not included in the foregoing. Thus I have what I call a model library, complete as it is, with some of the best works on mechanical engineering and mechanical drawing.

About a year ago I enrolled in a mechanical engineering course with a good correspondence school and while pursuing my studies I frequently find it necessary to refer to one or another of these catalogs to find some information on some particular kind of machinery that helps me so much with my studies.

It may be interesting for some of the other readers to note that when I arrived on my new job at a large power house I found that they had in use some automatic valves for controlling the feed water as well as pump governors, and of these things I knew very little because I never worked at a place where they were in use. Naturally these valves needed repairs and some of them needed new parts. Well the first thing that I did when I got on the job was to find out who manufactured these valves by referring to the name of the maker on the small brass plate which was attached to the valve.

I wrote to these people, asking for their catalog and received it in the course of a day or 2; then I read it and studied it, especially the diagrams, until I knew exactly how these valves worked and what to do when they didn't work, and in case I wanted new parts I was able to tell the boss just what was needed. Thus I was benefitted by my large supply of catalogs, which my wife thought was unnecessary.

Well, it only cost a few cents for postage to get all of these catalogs together and I might estimate that the total cost of getting this collection was about $1, including the paper, envelops and the stamps, and at the same time the letter writing improved my penmanship to such an extent that my writing now is readable which before was hard to read.

I have here in my library some catalogs that I like as well as some of the best books that are there, some of them in appearance excel those volumes for which I paid as high as $3. To get these catalogs watch carefully the books and catalog column of Practical Engineer.

Russel R. Ux.

BOILER FURNACES

I HAVE examined your elaborate and valuable issue of January, devoted to fuels and furnaces, and wish to commend your enterprise in presenting so much valuable matter. There are, however, some things to which I would call attention, as affording supplementary information concerning certain features presented.

Referring to page 62, the illustrations showing fire tiles for burnace roof were reproduced from the Peabody Atlas. On page 63, the author of this department has credited the tile roof furnace, as shown in the illustration, to Prof. L. P. Breckenridge. The foot note under the illustration reading—"Breckenridge Smokeproof Furnace." In this connection I would say that it is not a creation of his but was originated by W. L. Abbott, and the design shown is a copy of that employed for some 9 yr. in the Harrison Street electric power station in Chicago.

Referring to the improved boiler design on page 63, designated by a foot note as a Coking Furnace for Chain Grates, I would say that this was not designed to be what should be called a coking furnace. It is simply an adaptation of the tile roof furnace to a well known type of water-tube boiler. This design was made some years ago by me for an electric power station in the west and has been known as Bement's improved boiler.

A. Bement.

MUD DRUM EXPLOSION

ON getting ready to start up one morning early in October I was warming up the engine when suddenly there came a crash, and on entering the boiler room I found it filled with steam. I looked for the fireman but could see nothing for steam, so I shouted for him and found he had just come out as I went in.

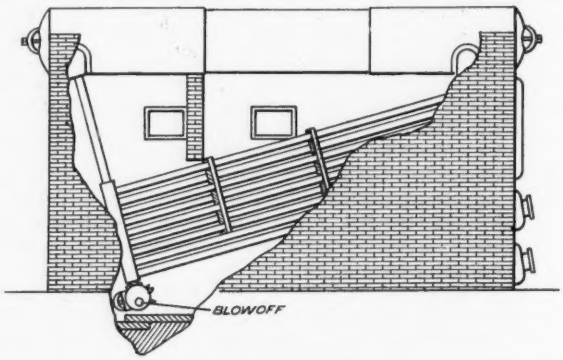


FIG. 1. BOILER SHOWING LOCATION OF WRECKED MUD DRUM

Finding he was all right I got on my hands and knees and tried to get to the front of the boilers, as the rear of the boilers is next to the engine room. This I succeeded in doing after climbing over brick and through water. I covered the fires heavily and

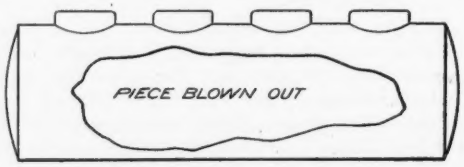


FIG. 2. BROKEN MUD DRUM

tried to get to the top of the boilers, but the heat was so intense that it drove me down again. I waited until the steam got out of the place and when I made an examination I found the wall blown down, and on further search, after some of the bricks and dirt were cleared out, I found that 1 mud drum had the whole side blown out of it.

When the drum was taken out and examined closer I found that it had been worn down to ⅛ in. in thickness, which was too thin to maintain the pressure any longer. The drums, 1 on each of the 2 boilers, were of cast iron, but have been replaced with cast-steel ones now. The one which did not explode was taken out a short time ago and found to be worn down to about 3/16 in. in some parts, so it was replaced with the same as the other. E. H. S.

THAT LOST WATER QUESTION

REGARDING the question asked in the January issue, as to what became of the water, or what was the cause of the loss of water, will state that I think the answer on page 149 of the February issue, would come short of the license getting percentage.

In the first place I believe that is a very good, practical question, and one designed to test an applicant's knowledge of the care and operation of steam boilers.

We must assume that up to the time of leaving that boiler, with the fire banked, everything was in as good condition as usual for the night, that there were no leaky valves, either steam or water, and that all seams, tubes, etc., had been perfectly tight; in short, no leaks of any kind, either from the boiler or its connections, had existed.

Since the bank had smothered the live fire, it is reasonable to suppose that the safety valve had not been blowing, so that no water had been lost in that way.

Now then, so far as the man's experience with this boiler up to the time he left it in the evening goes, he knows that no leaks of any kind existed and no steam got out through the safety valve; yet upon his return in the morning there is no water to be seen in the gage. Where has that water gone? It was there last night. It's not there now. There never have been any leaks, and so far as he knows all valves were shut and were tight last night, but the water is gone in spite of all his knowledge.

Now put yourself in this position with your own boiler, the boiler you are responsible for. Suppose that you were face to face with the conditions outlined herewith, and stated in the question, what would you do? Your actions under these conditions if they happened in your own plant, will be your answer to the question.

My duty to myself, to the license law and to my employers, is to know where that water went. No boiler or its accessories have ever been built that were indefinitely proof against leakage; therefore I would suspect that a leak in the water space had developed during the night, provided upon examination all valves were found to be correct. I would examine the ash pit and combustion chamber for evidences of dampness and if I found none, I would fill the boiler up above the second gage and carefully examine the boiler for leakage, and if none was found I would fill the boiler full of water and apply a hydrostatic test.

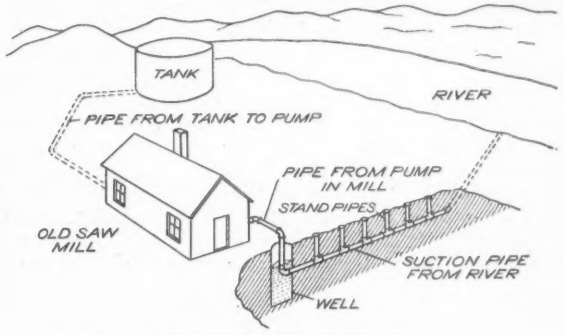
It is possible for the leak to be in the steam space or it may be of such a nature that pressure is required to force enough water through the opening for the leakage readily to be seen.

The whole thing resolves itself into the fact that the water got out; how, you do not know, but it is your duty and one that you must not slide past, to find out where that water got out, and before you attempt to get up steam you must, in all honesty to yourself and everybody concerned, know positively how that water did get out. Harry W. Benton.

SUCTION PIPE ARRANGEMENT

I ONCE put in a suction pipe from a river to a mill This was placed in a ditch which was dug about 8 ft. deep so as to be below the frost line. The distance from the river to the mill was about 300 ft., and on the suction pipe I placed stand pipes about 20 ft. apart with caps on the top, so they could be screwed off if the suction pipe got choked.

In order to locate the part of the pipe which was clogged up with sand, the discharge and suction pipes

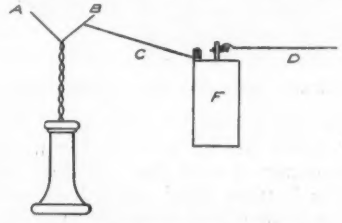


PUMPING ARRANGEMENT

from the pump in the mill were reversed and the water from the elevated tank forced by the pump back into the suction pipe, and if the water came through some of the stand pipes and not through others we could locate very closely the point at which the pipe was clogged. George Gifford.

LOCATING TROUBLE IN A TELEPHONE

I RECENTLY had a telephone trouble to locate and remedy, and I had quite a time to accomplish my job. It was in that of broken speech with funny actings. When the speech was cut off, a strong ring sent through the line would re-establish communication for at least a few moments. After trying every other



CIRCUIT TESTING DEVICE

trick I knew, as a last resort I made a circuit tester, a very simple one, right there on the job, and then I located the trouble.

Taking the receiver of the phone I connected it in series with a dry battery, as shown in the sketch. Now touching receiver tip A to the end of wire D, and holding the receiver to the ear, a strong, clear "click" was heard. This proved conclusively that the circuit through the receiver and receiver cord was alright. Now testing the 3 circuits of the phone in the same way, I found the transmitter circuit and the line ringing circuit alright. But when I came to test the receiving circuit through secondary coil, I did not get the "click" in the receiver. The trouble was therefore located here.

Taking the induction coil out, I tested the secondary winding and found it open. Examining closely I found a small puncture through the outside wrapping

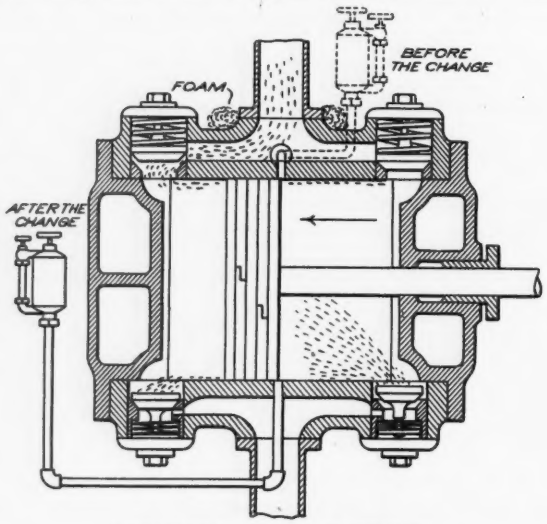
of the coil. Taking this wrapping off, showed that some way somebody had punctured through 2 or 3 layers of the secondary winding. A new induction coil ended the trouble that had been so hard to locate.

F. M. J. B.

LUBRICATOR ON THE EXHAUST PIPE

I SUPPOSE that most readers of Practical Engineer have heard of the engineer who changed the lubricator from the live steam pipe to the exhaust so it would be handy to fill. But how many have noticed the way most all air compressor cylinders are oiled?

I have visited several places, and all were oiled the same way. When I first took charge of a compressor I did not like to see the foam on top of the air cylinder and around the joint of the discharge pipe connection. I took off the head. I found the cylinder walls cut on the bottom and aways up the sides. I found that the oil entered the top side of the cylinder and realized here was a case of a lubricator on the exhaust. Look at the drawing and see how I made the change and how the piston in the first place scraped the oil to the



LUBRICATOR ON AIR COMPRESSOR

end discharge and the air forced it out. Note the way the piston scrapes the oil over to the intake and the incoming air sprays it over the cylinder surface. And also keeps the bottom oiled when it is not pumping. No foam is seen on top of the cylinder. W. A. Jones.

COMPOUND ENGINE RECEIVER PRESSURE

INDICATOR cards shown in the February issue from E. A. B.'s compound engine, are by no means bad, yet to calculate, with any degree of accuracy, the cutoff is an impossibility, so the best we can do is to assume conditions as representing the case, though for the sake of clearness I will exaggerate it a little in Figs. 1 and 2. Assuming his engine to be a Corliss and cutting off in the high pressure at ⅜ and the high-pressure valves operated by a single eccentric, it is plain that we cannot shorten the low-pressure cutoff without raising the receiver pressure and this receiver pressure is resistance on the high pressure the entire length of stroke as at D Fig. 2 and is bound to lower the high-pressure governors and cause the high-pressure cutoff to lengthen.

Now suppose he is running with 3 lb. receiver pressure and cutting off at 33 per cent in the low-pressure and say 38 per cent or about ⅜ stroke in the high-pressure cylinder, which conditions are represented in the full lines in Figs. 1 and 2. He says if he raises the receiver pressure to 10 lb. by shortening the low-pressure cutoff the high pressure will not unhook but follow the whole length of stroke. This is not surprising when we consider that the engine is already working near its range of cutoff in the high-pressure

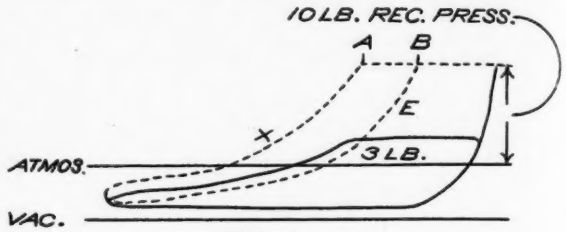


FIG. 1

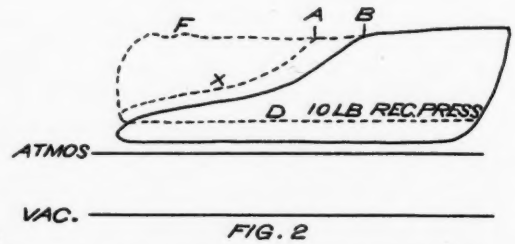


FIG. 2

FIG. 1.—LOW-PRESSURE CARD SHOWING EFFECTS OF CHANGING RECEIVER PRESSURE

FIG. 2.—HIGH-PRESSURE CARD EFFECTED BY RECEIVER PRESSURE

cylinder which, with any lap on the steam valves, is bound to be less than half stroke before the receiver pressure is raised.

When he raises the receiver pressure the high-pressure cutoff lengthens and, since it cannot lengthen much before it reaches its limit of range the only thing it can do is refuse to unhook and follow the whole length of stroke which is represented in Fig. 1, dotted line E, and in Fig. 2, dotted line F. It is easily seen why he cannot get the same results in raising the receiver pressure by shortening the low-pressure cutoff as he can by raising the receiver pressure by the additional exhaust from the steam pump, which is practically the same as opening the live-steam pipe attached to all receivers. Because in 1 instance he gets the 10 lb. by shortening the low-pressure cutoff, Fig. 1, dotted line E to B, and in the other instance, he gets the 10 lb. or more by letting the low-pressure cutoff remain where it is, Fig. 1, full line, and letting the pump exhaust into the receiver, raising it to 10 lb. or more, Figs. 1 and 2, dotted line X.

By noting the difference between the low-pressure cut-off in Fig. 1, A and B, with the high receiver pressure, it is not surprising that with the pump exhaust going into the receiver and a cutoff at A, Fig. 1, that it would do 20 hp. more work than the short cutoff at B, Fig. 1, and cause the low-pressure cylinder to keep the engine up to speed and allow the high-pressure cylinder to keep within its range of cutoff. It seems the only and most practical thing to do in this case is to let the pump exhaust make the receiver pressure if the resistance due to the 10 lb. or more back pressure is not so great as to interfere with the speed of the pumps.

A. C. Waldron.

Questions and Answers

Ask about your troubles—help the other fellow with his. Give your name and address. For a quick answer enclose stamp for reply.

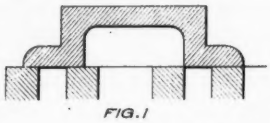
Babbitting Bearings

I WOULD like to have some reader describe in detail the proper way to run babbitt into a connecting rod box and the way to babbitt an eccentric strap. J. K.

Riding Cutoff and D Valve

KINDLY explain the difference between a riding cutoff and a common D slide valve? C. E. T.

A. The accompanying sketches are of the common D valve and the Meyer valve, one form of the riding cutoff type. You will note that the D valve is operated by one eccentric, while the riding cutoff has 2 eccentrics, the object of this valve being to cut the steam off rapidly and thus prevent wire drawing. The sketches clearly illustrates the operation.



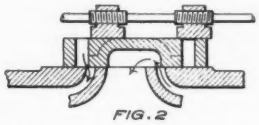
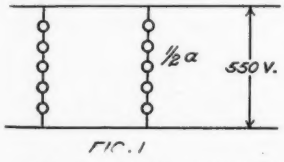


FIG. 1.—D VALVE
FIG. 2.—MEYER VALVE

Lamp and Motor Circuits

KINDLY explain by a diagram how to connect 110-volt lamps in series multiple and multiple series across a 550-volt, direct-current line and show how to calculate the current.



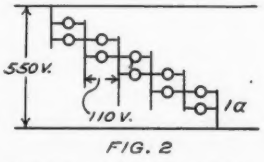


FIG. 1.—SERIES MULTIPLE CONNECTION OF LAMPS
FIG. 2.—MULTIPLE SERIES LAMP CIRCUIT

2. How do you connect a 2-phase, 4-wire, alternating-current motor to an autotransformer and how do you find the feed or positive wires of the motor and line? R. M. S.

A. The series multiple method of connection for a 550-volt circuit using 110-volt lamps would involve the connection of the lamps 5 in series and connecting these series across from one lead to the other of the 550-volt circuit. That gives 110 volts to each lamp or 550 volts altogether.

Suppose that you have 10 lamps to connect up. They would then be connected up in 2 series of 5 each and each series connected across the mains, as shown in Fig. 1. Just how you would pick out these lamps for connection would depend on the lighting that you wanted to get. You could use 2 2-lamp clusters on each series and a single lamp, or you could use a 3-lamp cluster and a 2-lamp cluster on each series, or 5 single lamps.

The multiple series method for 10 lamps, in order to compare with the other method, would involve connecting 2 lamps in parallel and connecting 5 of these 2-lamp sets in series, as shown in Fig. 2. This would give you 5 2-light clusters or you could arrange them in 2 4-light clusters and a 2-light cluster, or you could as before, of course, have 10 single lamps. In this case you would have to have the entire 10 lamps on at once. In the other case you could turn on either series of 5 separately.

The lamps will take 0.5 ampere each so that in the first case each series will take 0.5 ampere at 550 volts, while in the second case the multiple series connection to each pair of lamps would take 1 ampere, so that the entire series of 10 would take 1 ampere at 550 volts.

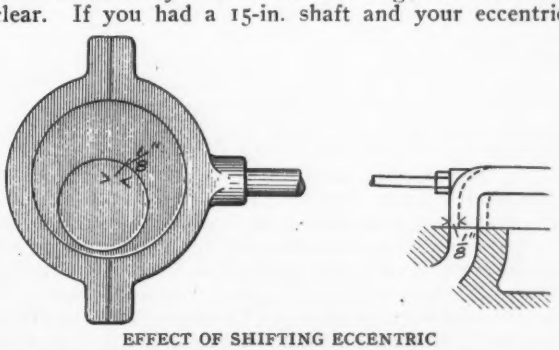
2. In connecting up a 2-phase 4-wire alternating current motor the 2 wires of 1 phase are connected to 1 phase of the transformer and the 2 wires of the other phase to the other phase of the transformer. A starting switch or box of some sort should be used.

If the rotation of the motor is wrong, reverse the connections of 1 phase, but in alternating-current circuits there is no such thing as a positive wire as current flows first in 1 direction and then in the other.

You would not be able to use a single auto-transformer on a 4-wire 2-phase circuit. There would have to be 1 transformer in each phase and you would then connect 1 pair of the motor leads to each transformer.

Effect of Shifting Eccentric

I WOULD like to see this problem explained, giving the solution by the means of a diagram to make it clear. If you had a 15-in. shaft and your eccentric had a 5-in. throw, how much would it change the lead of the valve to move the eccentric ⅛ in. on the shaft? L. W. B.



EFFECT OF SHIFTING ECCENTRIC

A. Your question is not quite definite, as in moving an eccentric ⅛ in. around a shaft the amount of motion depends on the point where the ⅛ in. is measured. I assume, however, that you mean the ⅛ in. to be measured at the center of the eccentric.

In this case and assuming that the valve is set

before moving, so that there is no lead whatever, that is, so that the valve stands just closed or just ready to open when the eccentric center is vertically above the shaft center, if the eccentric be turned forward ⅛ in. the valve will be pulled open ⅛ in., disregarding the very small effect which the angularity of the eccentric rod and the curvature of the arc of the circle would have. That is, turning the eccentric forward ⅛ in. would give ⅛ in. lead.

Technical Definitions

I WOULD like the definitions for the following words and abbreviations which I am unable to find in an ordinary dictionary: Phase, cycle, B. t. u., sp. gr., w. p. c., m. e. p. T. A. L.

A. The word "phase" refers to the time of action of an electric current. In alternating current the strength of the current or electromotive force starts at zero, rises gradually to a maximum, then falls to zero and reverses, rising to a maximum in the opposite direction and then falling to zero.

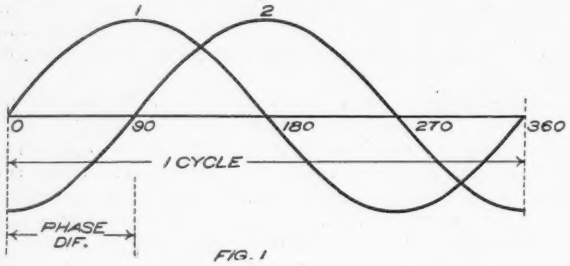


FIG. 1

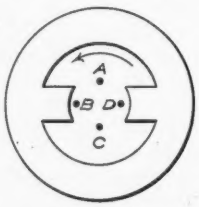


FIG. 2

FIG. 1. PHASE RELATION IN 2-PHASE GENERATOR
FIG. 2. RELATION OF ARMATURE WIRE TO POLE FIELDS

Where we have 2 or 3-phase currents it means that the point at which the current reaches zero in the different currents is different. When generating alternating current with a 2-pole machine, a wire on the armature will have this complete double reversal or cycle, as it is called, once each revolution. In 2-phase currents generally the zero of one current is opposite the maximum of the other and so are said to be 90 degrees apart in phase or time relation.

In Fig. 2, suppose the wire starts at position A, the electromotive force will be zero at that time. When it has gotten around to B, going in the direction of the arrow, the electromotive force will have risen to a maximum; when it has gotten around to C it will have fallen to zero again, and when at D it will again reach a maximum. Of course, when it again reaches A it will be at zero. Now, if we had another wire which started at D at the same time that the first wire started at A you will see that the rise and fall of electromotive force in that wire would be just 0.25 of a revolution, or 90 degrees behind the rise and fall in A, and the curve of electromotive force variation would be as indicated by line No. 2, Fig. 1. This would be 2-phase currents or a 90 degrees phase difference.

With 3-phase currents the same general action takes place, but the wires are usually spaced at 120 degrees apart on the circle, or we have a phase difference of 120 degrees, as it is called.

The cycle we have already defined as the complete double reversal of electromotive force, or current, in going from A through B, C and D around to A. In a multi-polar machine the cycle is passed through every time that 2 poles are passed by the wire or coil, regardless of the number of actual degrees on a circle through which the coil may have gone.

The B. t. u. is the British thermal unit and is the amount of heat required to raise a pound of water 1 degree in temperature.

Specific gravity is the weight of any substance as compared to the weight of an equal amount of water; i. e., if the specific gravity of iron is 7.02, it means that a cubic foot of iron will weigh 7.02 times as much as a cubic foot of water. The abbreviation for this is "sp. gr."

Your abbreviation "w. p. c." probably refers to watts per candlepower. This refers to the number of watts that a lamp uses per candlepower of light furnished. For instance, a 16-candlepower incandescent lamp may use about 54 watts, in which case it would take 54 ÷ 16 = 3.38 watts per candlepower.

"M. e. p." refers to the mean effective pressure in a cylinder, which is the mean pressure available to force the piston of an engine forward in its stroke.

Strength of Boiler; Heat to Raise Temperature of Water

CYLINDRICAL boiler is to withstand a pressure of 140 lb. a sq. in. How thick must the steel be if the boiler is 48 in. in diameter?

2. A circular tank filled with water is 2 ft. in diameter at the top, 15 ft. at the bottom and 15 ft. deep, the temperature of the water being 100 deg. F., what is the weight of the water in the tank and how many pounds of coal which gives 13,500 B. t. u. a pound would be required to evaporate the water?

3. A cylindrical boiler is 4 ft. in diameter, 18 ft. long and made of steel 1.038 in. thick, what is its weight?

4. With water at 40 deg. F. would you use a feed pump on an injector? I would advise the use of a feed pump for this will run with 40 lb. of steam when an injector will not.

5. A lodge in a mine is 26 ft. long, 8.5 ft. wide and 7.5 ft. deep; if it is full of water how long will it take a 4 in. pump running at a piston velocity of 100 ft. a minute to empty it?

A. In your first question you do not give the strength of the steel to be used. I, therefore, assume this at 60,000 lb., and taking a factor of safety of 6 gives 10,000 lb. as the working tensile stress. To find the thickness multiply the pressure per square inch by the diameter of the boiler in inches, and divide by 2 times the working stress. This will give 140 x 48 ÷ (2 x 10,000) = 0.336 in.; ⅜-in. plate will, of course, be used, as that is the nearest size.

2. The volume of a tank is found as follows: Square the larger diameter, equals 225. Square the smaller diameter equals 144. Multiply the larger by the smaller equals 15 x 12 = 180. Add these 3 values together, equals 549. Multiply this value by the height and by 3.1416 and divide by 12. This quotient will be the contents in cubic feet, equals 2160. A cubic foot of water at 100 deg. F. weighs 61.97 lb. The weight in the tank will, therefore, be 2160 x 61.97 = 133,900 lb. You do not state the pressure for evaporating the water, but I presume it is atmospheric. In

that case the temperature of the water must be raised to 212 deg. This will require for each pound of water 212 — 100 = 112 B. t. u., and to evaporate a pound of water will require 965 B. t. u. The total heat required for each pound of water would then be 112 + 965 = 1077 B. t. u. and for 133,900 pounds the heat required would be 133,900 x 1077 = 144,100,000 B. t. u.

If a pound of coal gives 13,500 B. t. u., the pounds required would be 144,100,000 ÷ 13,500 = 10,680 pounds. These figures have been worked out on a slide rule and are only approximately correct, but if you figure through by arithmetic you will find that they are about right.

3. The weight of steel is 0.2834 lb. to the cubic inch. To find the cubic inches in the boiler shell, the circumference of a 4-ft. boiler is 48 in. diameter, is 150.7 in. The length, 18 ft., is 216 in. The area of the shell will then be 150.7 x 216 = 32,600 sq. in. The area of the heads will be 1809.5 sq. in. in each head or 3619 sq. in. for the 2. Adding this to 32,600 gives 36,219 sq. in. as the area of the shell and heads. The thickness is 1.038. Multiplying the area by the thickness gives 36,219 x 1.038 = 37,630 cu. in. of steel in the boiler shell. Multiply this volume by the weight of a cubic inch gives 37,630 x 0.2834 = 10,665 lb.

4. You could use either pump or injector with water at 40 deg.; 40 deg. F. and 40 lb. pressure have no relation to each other, so that your answer is not correct. The steam pressure you have not stated in your question. The decision between the pump and injector becomes a matter of the circumstances in the plant. A steam pump is handier because you can regulate the rate at which it feeds the boiler, and if you have a feed-water heater so that the exhaust from the pump can be used to heat the feed water, the pump will not waste much of the steam. On the other hand, the injector costs less than the pump and all the heat that it takes from the steam goes back into the boiler.

5. A lodge 26 by 8.5 by 7.5 ft. will contain 26 x 8.5 x 7.5 = 1951 cu. ft. of water. A 4-in. pump has a diameter of ⅓ of a foot, consequently an area of 3.1416 x $(⅓)^2$ ÷ 4 = 0.0873 sq. ft. The volume pumped in 1 minute, without allowing for slip will, therefore, be 0.873 x 100, or 8.73 cu. ft. The time required will, then, be 1951 ÷ 8.73 = 223.5 minutes or 3 hr. 43.5 minutes.

Power of Triple-Expansion Pump

I AM running a Scranton triple-expansion pump and would like to know how to find the horsepower of it. Steam pressure is 90 lb., length of stroke 36 in., diameter of low-pressure cylinder 34 in., diameter of intermediate cylinder 21 in., diameter of high-pressure cylinder 13 in., number strokes a minute 46, and a 14-in. water end. G. W. D.

A. As to the power developed by your pump, we have to figure this from the probable reduction of pressure. There will be a certain amount of drop between cylinders due to the wire drawing of steam in the ports, but there is no way of telling what this will be.

Starting with 90 lb. gage pressure, which is equal to 105 lb. absolute, the steam in going from the high-pressure cylinder to the intermediate will drop directly in proportion to the areas of the 2 cylinders. A 13-in. cylinder has an area of 132.73 sq. in., a 21-in. cylinder 346.36, and a 34-in. 907.92. The pressure in the intermediate cylinder will, therefore be 105 × 132.73 ÷ 346.36, or 40.2 lb., and in the low-pressure cylinder it would be 105 × 132.73 ÷ 907.92, or 15.03 lb. This will be the forward pressure.

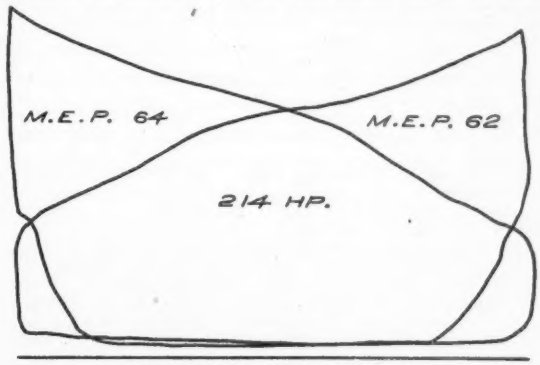
For the high-pressure cylinder the back pressure will be, of course, the 40 lb. of the intermediate cylinder, and for the intermediate cylinder the back pressure will be the 15 lb. of the low-pressure. You do not say how the low pressure exhausts, but I have assumed that it exhausts at atmospheric pressure, which would be, of course, 15 lb. absolute. In this case the low-pressure cylinder is doing no work, as the steam comes in at the same pressure that it goes out. This means simply that for the proportions that you have the third cylinder is of no value for a steam pressure of 90 lb. A higher steam pressure should be used if the triple-expansion pump is to show any gain in efficiency over a 2-cylinder compound. The power of each cylinder will be found by the regular horsepower formula: Mean effective pressure times length of the stroke in feet, times area of the piston in square inches, times the working strokes, divided by 33,000.

You speak of the pump making 46 strokes a minute, which I conclude is the number of single strokes. In that case, for the high-pressure cylinder you would have 65 × 3 × 132.7 × 46 ÷ 33,000 = 36 hp. For the intermediate cylinder the mean effective pressure is 40 — 15, or 25, and the power is 25 × 3 × 346.36 × 46 ÷ 33,000 = 36.25 hp. For the low-pressure cylinder, as the mean effective pressure is zero the horsepower is zero.

Cards From Hydraulic Dredge

ENCLOSED you will find a card taken from an hydraulic dredge. I wish to know what horsepower is developed and could there be any changes made to better the operation of the engine? The engine is of Atlas type, common slide valve with throttle governor. P. C. O.

A. By means of a planimeter, the mean effective pressure indicated by the left-hand card is found



CARDS FROM HYDRAULIC DREDGE

to be 64 lb. and by the right 62 lb. The engine being 18 by 24 in., running at 110 r. p. m. and the indicator spring 50 lb. the horsepower is calculated to be 214.

Although all throttle-governed engines have considerable wire-drawing, this defect is very marked in the cards which you enclosed and the cutoff is so indistinct that it is almost impossible to tell where the expansion line commences. The expansion line on these cards is very short and the pressure at release is too high for economical operation. To remedy this, I would suggest that the cutoff be made earlier. The irregularity in the compression line in the left-hand card indicates that there must be some leakage through the valve. This fact is also indicated by the rapid falling off of pressure after admission. Therefore, I should suggest that you tighten up your valve and make the events of the cycle earlier.

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TYPES OF BOILERS

It has long been considered that the water-tube boiler is the only kind adapted for large powers on account of the large size of drum needed in the tubular and the thickness of shell required for the necessary strength. On the other hand it has been thought that the water-tube boiler is not so well adapted for small powers because of the cost, and the room taken up for the divided water and steam space.

Recent progress shows that the water-tube type can be made in small sizes at as small space requirement as the tubular, and for the large sizes, the drum diameter to give sufficient steam space becomes large enough to be a problem. The only remedy is to subdivide the steam space which has objections on account of the additional cost and the space taken up.

Forcing, which was considered the prerogative of the water-tube species has been shown to be possible with the tubular to nearly if not quite as great a degree. There seems to be little left to choose between the 2 types except in matter of adaptability to the work in hand and the space where the boiler is to go; and each case must be decided on its own merits as in any other engineering problem.

As a guide to such a consideration, the article by Mr. Moses in this issue is of the greatest value, and the reader who gets the points of this article well in mind will be well equipped against the time when he is called on to give a decision in regard to a boiler for a special case.

Between different arrangements of the water-tube type, the difference does not seem to be great as regards performance, and again it will be a question of choosing the one best suited to the particular case in hand.

In any case, the results of recent experiments seem to show that the best economic conditions will be obtained, that is the biggest return per dollar invested and running cost when the boilers are run at as high a capacity as can be secured with the draft available. The idea that a boiler loses greatly in efficiency when forced does not seem to be warranted by the facts; there is a slight loss, but not enough to offset the gain in interest and depreciation charges for the bigger apparatus.

The net result of the modern knowledge of the subject is then to choose the type of boiler which, on the whole seems to be best for the plant, to get plenty of draft, and furnace, and to run the boiler at high capacity. Under these conditions, there is no great advantage in using big units except to cut down the space required, and the gain from being able to cut out all the boiler except that absolutely needed at any time, will pay for the extra space if it is to be had.

ANDREW W. WOODMAN AND ALBERT B. MOORE have formed a partnership under the name of Woodman & Moore, to act as consulting engineers in civil, mechanical and electrical engineering, with offices at 184 La Salle St., Chicago.

GRAPHICAL DIAGRAMS OF MECHANICAL ACTION

It seems that there is much to be learned yet in regard to the action of some forms of steam valves, much as the subject has been studied. It is costly and a nuisance to make a model of every type of valve that it is desired to investigate, and after it is made a valve will often be a little too short or too long, and to get it just right requires a deal of fitting with likelihood of getting it wrong after all.

Diagrams as they look when completed are complicated, but the method of making them is simple and they save a great amount of time when their use is understood. The one most in use is that devised by Zeuner, and for some work it is beyond question the best; but for the ordinary study of the working of a valve, the diagram of Bilgram, which is now being explained in the columns of Practical Engineer is easier to draw and to read.

Before the use can be explained, it is necessary to understand the reason why of the diagram, and the method of reading it, and as in most things that is not particularly interesting; when the use is understood, however, the design of a valve to fit any given set of conditions is quickly made, and the study of the effect of changing the dimensions is as easy as drawing circles. These labor saving drawing methods (or graphical methods) are well worth mastering, and after they are once understood, there are countless ways in which the same methods can be applied to other problems than that of valve design.

One of the most common of these is the study of electrical circuits, especially alternating-current circuits, and he who has become familiar with the handling of the valve diagram is well fitted to grapple with the method of study of the transformer, the alternating-current generator and motor.

MOTOR GOVERNING

To one who sees it for the first time it seems that a motor connected to the mains which supply electric current, and having no device to control the amount of current that flows would run away, if the load is suddenly released and the motor left to run light. Nothing of the kind happens, however, and the only result is a possible slight increase in the speed. The question arises, "Whence this remarkable self-control of the motor? Why does it not take the same current without as with load? And what becomes of the extra power?"

This feature of self regulation is indeed fortunate, as it does away with any necessity for external governing devices which would be needed as in the case of the steam engine if the power kept up when the load ceases. And for many of the small divisions of power for which motors are used, a separate governor for each motor would add seriously to the complication and expense.

The reason for the automatic current control is shown clearly in the article by Mr. Le Tellier. And it should be noted that this control applies only to the shunt wound motor, for if the series wound type is left to its own devices, there will be a merry race when the load is thrown off.

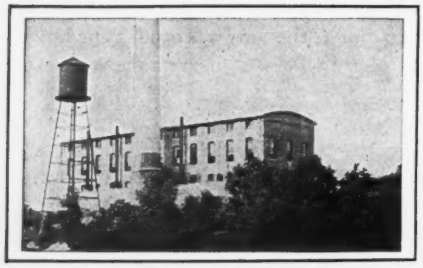
In handling the motor, the difficulty is not to get the speed to stay the same, but to get it to vary through as wide a range as is desirable for the control of the speed of the driven machinery, and numerous devices have been invented for this purpose. The simplest is to change the strength of the field current, but this causes a liability to sparking, if the weakening is carried too far, or poor efficiency, if the strength is made too great. Resistance in the field circuit, combination field windings, movable pole pieces, special speed control poles are some of the methods used, all of which aim at wider control of the field strength without making trouble. To attack the problem from the other end, the voltage applied to the armature terminals must be changed, and this is done either by resistance in the armature circuit or by several voltages any one of which may be used.

In any case the motor speed will be practically constant so long as the field strength and the electromotive force applied to the brushes are constant, due to the automatic change of the counter-electromotive force with speed. As in the case of governing the steam engine, there is a slight change in speed, but it is so small before the automatic action takes place, that the amount is of little or no consequence in actual work.

SIMPLE FORMULA FOR WELDING CAST IRON

A formula for welding cast iron, developed by Messrs. A. Beltzer and C. Delcampe and published in the Iron and Coal Trade Review, calls for a flux consisting of 15 per cent lithium chloride, 20 per cent potassium fluoride and 60 per cent potassium chloride. The cast-iron surfaces to be welded are preheated, and then covered with the flux powder and heated to the melting point. Additional material is supplied from a rod of cast iron which is also dipped in the flux and presented to the joint where it melts and flows in, filling up the space and making a sound weld. It is claimed that blow holes in castings may be filled by the addition of cast iron in the above manner and that metal may be added to defective castings to build them up where defective. In short, this can be made a "putting on" process where required. The means for heating are not given, but probably any nonoxidizing flame capable of raising the temperature to the melting point of cast iron can be employed.

AT THE ANNUAL ELECTION of the Modern Science Club, held April 12, the following officers were elected: President, Wm. G. Freer; vice-president, J. A. Donnelly; secretary, J. P. Bonney; financial secretary, C. H. Haggerty; treasurer, Geo. O. Kaley. Board of Directors: F. J. Wood, J. W. Sterrett, E. F. Gennert, A. B. Pinney, J. P. Martin, J. L. Weinert, W. T. Wheeler, Wm. Smith, Frank Martin and J. H. Baumann.



Power Apparatus

In Shop and Market

New Ideas in Making, Buying and Selling

ADVERTISING OF GASOLINE ENGINES AND ACCESSORIES FROM AN ADVERTISER'S STANDPOINT*

By M. A. Loeb

TAKE up 5 or 6 old copies of any trade publication and you will find that any number of advertisements of some particular concerns are exactly the same as the first day they started to appear. There is the name and address of the manufacturer, a cut of his engine, which may or may not be correct. In fact, nothing else except his name and the picture of his engine. You will not wonder why that manufacturer's advertisement does not pay him.

There are, of course, all kinds of successful advertising. A merchant runs a "card" in his local newspaper and calls that advertising. A manufacturer timidly tries a 1-time order in a bargain magazine and calls that "advertising". Another sends a pretty Christmas present to his big customers and calls that "advertising". Advertising is very different. It is something deeper, stronger, more powerful. Advertising means going to your public with a sincere message of what you can do for them. It means telling your story in the manner that fits it, with the frequency and variety that it may require. Sooner or later, depending on what you have to say and the way you say it, you will win your public. That is advertising.

Good advertising is not ransom or blackmail. It is the most effective weapon for business aggression and defense. A good product pushed by good advertising —this is the formula.

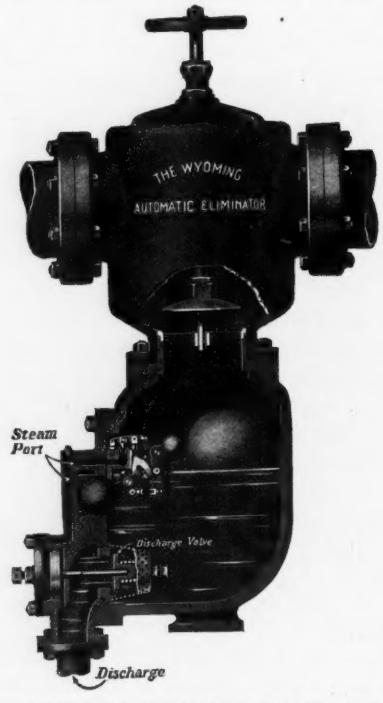
Advertising prominence helps a man in anything he may undertake. If you have built up a reputation advertising some specialty, your reputation is established ready to help you in exploiting some other specialty, and this additional advantage costs you nothing. Suppose, for instance, that the makers of a reputable and widely advertised brand of engines should start to manufacture automobiles. They could introduce these automobiles to the trade with much less advertising expense than an unknown firm could. This is the way many large businesses have grown. It doesn't cost as much as one may think to get a wide reputation—a reputation that will instantly win favor for your goods.

The man who does things makes some mistakes, but he never makes the biggest mistake of all—doing nothing. It may require a little more courage to invest in advertising than in new machinery, for instance. Because it does require more courage, and is less obvious, there is greater reward in store for the man who successfully advertises. And I feel confident that if you members of this association would devote a little more of your own personal time and attention to your advertising during the coming year, that you will find that the results obtained will more than repay you. The sale of anything possessing merit can be increased by the use of good advertising.

*Abstract of paper read at the National Gas and Gasoline Trades Association.

THE WYOMING AUTOMATIC ELIMINATOR

THE W. H. Nicholson Co., of Wilkes-Barre, Pa., has just issued a most pleasing catalog with special embossed cover and illuminated page border designs describing in detail the Wyoming Eliminator of different types and showing how it operates. This apparatus has been designed with a full comprehension of the trouble which moisture in steam will cause in the running of steam machinery and is planned, therefore, not only to separate the moisture from the steam but to discharge this water or other



THE WYOMING AUTOMATIC ELIMINATOR

extraneous matter automatically without the loss of steam, thus taking care not only of natural condensation but handling any flooding which may occur.

A discharge valve is provided which, in the event of flooding the separator, stands wide open until the flow of water has ceased, this effect being produced by a trap placed in the lower part of the separator and controlled by a ball float. The outlet is of such capac-

ity that in an 8-in. eliminator there is a 3-in. discharge opening, the discharge valve being from 3 to 4 times as large as used in ordinary steam traps.

Between the separator and the collecting chamber is a stop valve for cutting off the steam line from the collecting chamber and trap when it is desired to clean out the latter or make repairs. The separator has a series of serrated baffle plates, against which steam impinges, and down the grooves thus formed the moisture trickles to the vessel below.

When flooding occurs, the ball float rises with the water level until a certain point is reached, when the lever trips out a latch. This releases a weight on an arm which controls the steam operating valve and this steam valve is instantly raised, opening the live steam port which communicates with the cylinder. The piston then moves over and pushes the discharge valve wide open. These conditions will be maintained until the water has been discharged to a level a few inches above the discharge valve, when the float, which follows the water down and at the same time raises the weight again, permits the latch to drop into position, closing the steam valve, and the steam in the small cylinder escapes through an exhaust passage into the discharge.

This valve movement is quick acting and when the discharge valve opens it comes wide open at once, thus avoiding any wire drawing of either steam or water. When the valve closes it shuts clear down, so that it always stands either wide open or entirely closed. The secret of getting this condition is the steam operation of the discharge valve.

Steam cannot escape through the discharge valve, as there is at all times at least 2 in. of water above this valve.

Capacities of the Wyoming eliminator run from 13,000 gal. an hour on the 3-in. size up to 160,000 gal. an hour on a 16-in. size. Sizes up to 12-in. are carried in stock and larger sizes can be made up for prompt delivery.

The eliminators can be furnished with either standard, special or extra heavy flanges and with companion flanges to correspond. The horizontal type is shown in the illustrations, but a vertical type is made which operates on the same principle.

STANDARD MEAN EFFECTIVE PRESSURE COMPUTER

FOR those who have occasion to compute the horsepower of compound engines, one of the most convenient devices which we have seen recently is the mean effective pressure table devised by W. B. Mayo, General Manager of the Hooven, Owens, Rentschler Co., Hamilton, Ohio. This figures the mean effective pressure as referred to the low-pressure cylinder only, and for noncondensing engines it is based on a back pressure of 15 lb. absolute in the low-pressure cylinder and 20 per cent loss from the theoretical indicator card. The number of expansions is determined without considering clearance. For instance, using 20 and 40-in. cylinders, with cutoff at ¼ stroke, the cylinder ratio would be 4, the expansion ratio in the high-pressure would be 4, or the total expansions would be 16. If the engine takes steam at 150 lb. gage pressure the mean effective pressure table gives directly on a single reading the mean effective pressure in the low-pressure cylinder as 19.7 for a noncondensing engine, or 29.9 for a condensing engine.

The condensing engine is based on 26 in. vacuum and correction factors are given for other vacuums, also corrections for extremely long cutoff and for high-speed engines. The tables as made out are for Corliss engines.

The making up and describing of this mean effective pressure table is for the purpose of trying to effect a standard basis for figuring engine horsepowers so that all manufacturers and purchasers will figure their power on the same basis. These tables are already in use by several of the Corliss engine builders.

The 20 per cent deduction from the theoretical indicator card was obtained after measuring a great many Corliss engine cards by different manufacturers and from engines with different clearances; this loss is a fair average.

The reason for making a deduction for high-speed engines is to take into account such losses in the card as are due to increased clearances, compression and rounded corners that are not found in slow-speed engine cards.

The deduction or corrections for long cutoffs is to allow for more wire drawing on the inlet passages and increased back pressure caused by engines being heavily overloaded.

Those who have occasion to use such a table as this can be supplied with a copy by writing to the Hooven, Owens, Rentschler Co., at Hamilton, Ohio.

AN ALL-AROUND CONVENIENCE

ANY engineer will remember the innumerable times when he has wanted a trestle or horse for supporting pipes or parts of machinery on which he was engaged in working. When such a trestle is wanted it is never to be had, because either the lumber is not handy, or there is not time to put

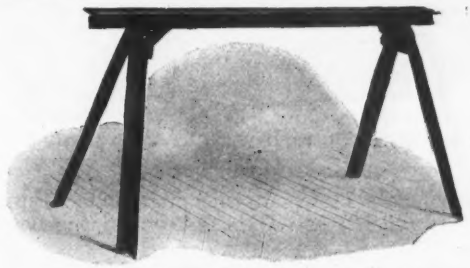


FIG. 1.—COLLAPSIBLE HORSE READY TO USE

one together, or you don't want to use it long enough to pay for bothering with it, and it takes too much room to store these horses after they are made.

For just those conditions the collapsible steel trestle, made by the S. M. Hildreth Co., of New York

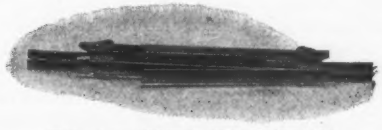


FIG. 2.—FOLDED FOR STORAGE

City, will be found the right thing. As shown by the illustrations, it is manufactured from angle iron and is therefore rigid and strong. It is made in several heights and lengths so that the proper size can be gotten to fit any conditions, and the legs fold up when the trestle is not in use, so that the device can be stored in very little space, and conveniently carried about. It is light in weight and once put into the plant is always quickly available when wanted. Its uses are so obvious and so numerous that to know about these trestles is to want them.

THE CASADAY SYPHON BOILER CLEANER

KEEPING the inside of a return-tubular boiler free from scale-forming material and residue left by the feed water is one of the most irksome duties which the engineer has to perform, and the necessity can hardly be overestimated as the efficiency of the entire plant and the safety to the workmen depend largely upon the condition of the boiler plate.

Connecting a single blow-off pipe to the lowest point of the boiler can hardly be recommended as good practice in the modern power plant. There have been many improvements to this method, and one of the most recent is that presented by the W. L. Casaday Mfg. Co., of South Bend, Ind. The Casaday Syphon Boiler Cleaner is adapted to be arranged in the boiler in such a manner that the steam in the boiler may be employed to form a suction and blowoff, whereby all scale and mud as well as floating precipitates in the boiler will be removed.

In the accompanying illustration, Fig. 1, is shown a longitudinal section of a boiler equipped with the Casaday Cleaner, and in Fig. 2 is shown the cleaner ready to be installed in the boiler.

As will be noted, the cleaner is arranged in the lowest part of the boiler, beneath the tubes, and consists of an inverted V-shaped shield plate, to the outer

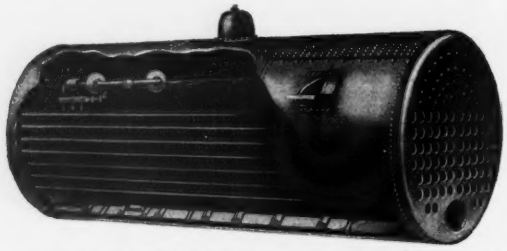


FIG. 1.—BOILER EQUIPPED WITH CASADY SYPHON BOILER CLEANER

side of which is attached projecting, inclined, supporting legs, which rest on the bottom of the boiler as shown.

Arranged in the boiler at any suitable place and communicating with the upper portion are 3 pipes, the lower ends of which are connected to a series of discharge nozzles in the bottom of the boiler.

Each nozzle is provided at one end with a reducer or beveled edge so as to fit within the reamed opposite end of the next adjacent nozzle, and each nozzle is secured to the shield.

The first nozzle is threaded into the elbow and has a beveled front end. The last nozzle projects into the reamed end of a sleeve of the same diameter as the nozzle. This sleeve is mounted upon the shield and is connected to a connecting pipe communicating with the discharge or blow-off opening. The blow-off pipe is, of course, provided with a valve, which prevents the operation of the device, except when needed.

Connected to the upper end of the 3 vertical pipes is a skimmer or device which removes all foam and foreign matter from the surface of the water. The large ball shown acts as a float to keep the short perforated pipe on the surface. The sediment and foam are carried away through the perforations in the short pipe connecting the ball with the long single pipe. The short pipe connected to the 3 upright pipes is simply an auxiliary. Three pipes are employed to carry the skimmings from the surface of the water in order that sufficient volume may be discharged and at the same time allow the pipes to pass between the tubes. Live steam is used to form the syphon, thereby allowing all the water to be used in the boiler.

To install this cleaner, no holes need be cut in the boiler; the outlet to the syphon is dropped inside of the blow-off pipe. When the blow-off is opened, the system of syphons sweep all deposits from the inside of the boiler, leaving no sediment to form scale.

SOOT DAMAGE

FACTORY chimneys, in the opinion of M. C. Huyette, as voiced in an address before the Buffalo Association of Engineers, are responsible for a damage of $5,000,000 a year to Buffalo alone. This seems like a big item, but Mr. Huyette's figures stood the test reasonably well. His opinion was that "Smoke is an evidence of stupidity and not a sign of

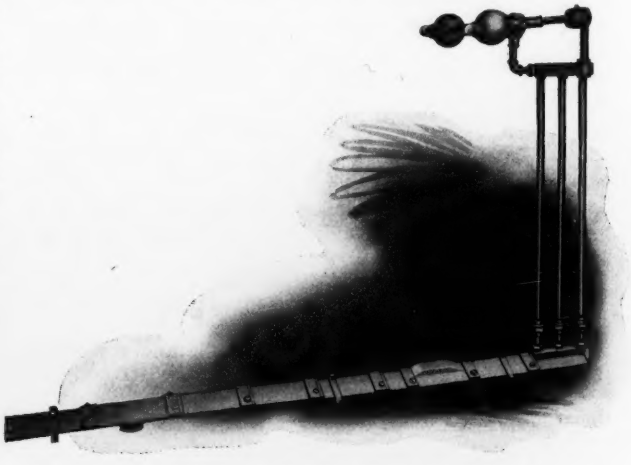


FIG. 2.—CASADY CLEANER READY TO INSTALL

prosperity," that the imperfect combustion, which has as one of its results the production of smoke and soot, wastes 25 per cent of the coal burned in power plants and that the hand-stoked furnace, carelessly fired, is responsible for a large part of this waste. Mr. Huyette showed from figures and results of tests that in a number of plants the saving in fuel from the installation of mechanical stokers was equal in one year to twice the cost of installing the stokers. This means, however, that the stokers must be properly handled and that the instruments for determining the correctness of combustion must be used conscientiously so that the engineer may know what kind of fuel he is getting and how well it is being burned.

Mr. Huyette spoke of the suffering from smoke in every home and building in the city and stated that the city might collect $80,000 a year in fines from the Federal Building and a total of more than a million dollars a year if the offenders were punished as they might be under the Buffalo ordinances.

REEVES PULLEY CO. announces the appointment of W. C. Wilcox as manager of its Chicago branch, to succeed E. O. Winterowd, who resigned. Mr. Wilcox has for years been actively and intimately associated with the management of this branch, and with his undoubted ability and increased facilities he will merit a continuance of the patronage and good will which has been enjoyed in the past.

RESEATING THE WHITE STAR AND MODEL STAR VALVES

INJURY to the seat of a valve by scale, sediment, pipe chips or erosion of steam is almost certain to come sooner or later, no matter what care is exercised in the handling of the plant. When such an accident happens the problem is how to reface the seat of the valve so as to make it again available for use. For the White Star and Model Star valves, which are made by the William Powell Co., Cincinnati, Ohio, a special reseating tool has been designed which will save its cost many times by avoiding the replacing of valves.

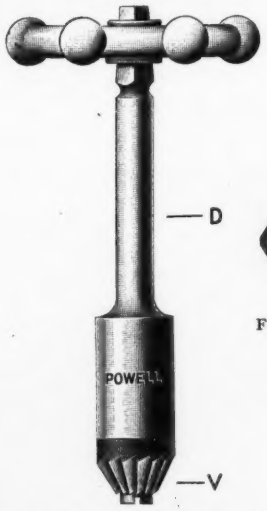


FIG. 1.—RESEATING TOOL FOR SMALL SIZES OF WHITE STAR VALVES

FIG. 2.—CUTTER FOR LARGE SIZES OF VALVES

Figure 1 shows the tool for small sized, ¼, ⅜ and ½-in., with the valve wheel in position so that the cutter is ready to do service. The cutter is made of the best quality of steel, the only part subject to wear being the file disk which is hardened and tempered and will last a long time. This disk is made for the larger sized valves as shown in Fig. 2 and has 2 faces, both of which are usable.

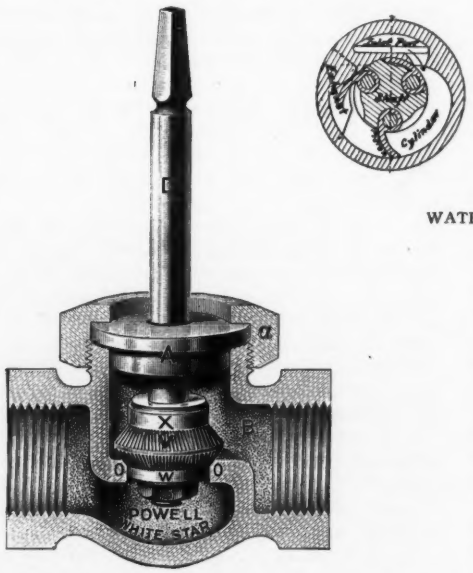


FIG. 3.—RESEATING TOOL IN THE BODY OF A GLOBE VALVE

Figure 3 shows the tool ready for use in the body of a globe valve. The parts are a steel reseating stem, D, guide collars A and W, to keep the cutter true, a shoulder collar, X, a double faced file, V, and a locknut, S.

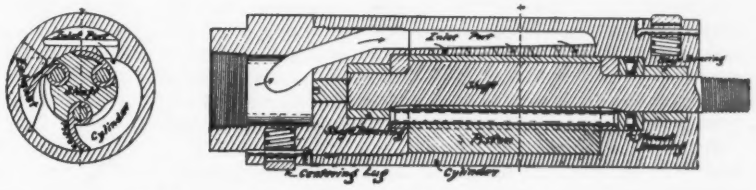
To use the tool the trimmings are unscrewed from the body of the valve, the wheel handle is released, the hexagonal union nut, a, is removed and the reseating tool dropped into the valve body. It is clamped firmly into position with the union valve nut, a, and by means of a bitstock or the valve wheel handle the stem D is turned to the right until the seat is smoothly refaced. The file cuts rapidly so that but little strength is necessary and the refacing should be carried only far enough to get a clean, smooth surface. After the tool is removed, the disk and seat should be ground together with fine emery powder and the valve will then be in as good condition as when leaving the Powell factory.

THE DEMON TUBE CLEANER

HEREWITH is illustrated a new form motor for driving tube cleaners. A great deal of trouble has been experienced in removing scale in feed-water heaters, single and multiple effects, condensers, small boiler tubes and other industrial tubes running from 2 to 3 in. in diameter.

The principal obstacle in the way of the manufacturers of mechanical tube cleaners has been the problem of designing a motor small enough to enter the tube and yet which would develop an abundance of power to remove the scale in a reasonable time.

In the Demon cleaner here illustrated it will be noted by referring to the sectional view, that the hydrostatic pressure is used directly upon rotary pistons. In the usual form of tube cleaner a small turbine wheel is used but the diameter and consequently the power of the turbine must be so much reduced in order to make the cleaner sufficiently small to enter the tube, that the result is a very weak form of motor. In the Demon type of cleaner the pistons are arranged lengthwise or parallel with the tube so a comparatively large piston area can be secured.



WATER MOTOR FOR THE DEMON TUBE CLEANER

The motor consists primarily of a body and a main shaft located centrally. Hinged longitudinally with the shafts are 3 pistons which are so arranged that the water automatically throws each one in turn in its working position and each piston folds in when the water has rotated the piston to the exhaust port. The water can not escape until it has done its work.

The result is that this small cleaner develops sufficient torque or twisting power to remove quickly and thoroughly any incrustation which may be found in these tubes.

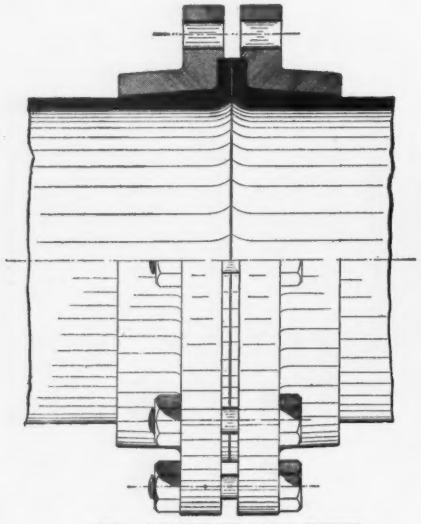
In order to produce an uniform action of the cutter head on all sides of the tube, the cleaner is held cen-

trally in the tube by centering lugs. The cutters are mounted on 2 arms or shafts which are pressed tightly against the scale by stiff springs within the cutter head body. In this way the cutters are forced to cut and cannot slide over and pass by the scale.

The manufacturer of these machines is the General Specialty Co., Buffalo, N. Y.

SPECIAL PIPING

WELDED Steel Headers, Nozzles and Flanges as made by W. K. Mitchell & Co., of Philadelphia, are an important feature in large power plant piping. Welded piping reduces the number of joints in a system, eliminates heavy fittings of all kinds, decreases the cost of headers and avoids flaws in the material. These headers which



THE MURDOCK PIPE JOINT

are of welded steel are absolutely solid, and can be tested to any reasonable pressure before erecting them, so that satisfaction is assured.

Besides headers, this company makes a specialty of pipe bends, made up from wrought iron or steel pipe, as may be desired. Two forms of special lap joints are made by this company, one the Improved Recessed lap joint, which has the ends of the pipe beaded out and setting into recesses in the flange, the other the Murdock improved lap joint, made especially for high pressure, and in which a collar is welded to the end of the pipe and this end is then turned over, carrying the collar with it by the usual method. The flanged end fits into the recess of the flange proper which is usually made of steel. To insure a true joint, the end of the pipe both on the back and front and the surface of the collar where it fits into the flange are all carefully turned, the collar being on a regular taper, from the back of the lap to the end of the hub. This method gives uniform bearing all over between the flange and the end of the pipe, thus insuring true alignment and a tight fit.

AFTER MAY IST, 1910, the general offices and laboratory of the Dearborn Drug and Chemical Works will be located on the 20th floor of the McCormick Building, Michigan Ave. and Van Buren St., Chicago. This change has been made necessary by the extensive growth of the company's business, making the present quarters in the Postal Telegraph Building too small.

CASKEY BLOW-OFF VALVE

BECAUSE of the great amount of water that is suddenly discharged from a boiler and the shifting of the sediment, the operation of blowing down is one of the most dangerous which the engineer has to perform. In order to withstand the strain the blow-off valve must be designed and constructed with the greatest care.

In the accompanying illustrations are shown views of the Caskey blow-off valve which allows the discharge to pass straight through without any choke or taper. The cause of failure of many valves is due to pockets where sediment lodges, becomes hard and causes the valve to deteriorate. This cause of trouble is entirely done away with in the Caskey valve as there are no pockets or places where sediment can lodge.

The valve consists of a body a, a straight plug b, and a bushing c, ground to fit the plug. Perfectly

FIG. 1.—CASKEY BLOW-OFF VALVE

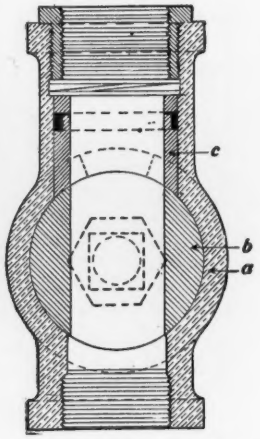


FIG. 2.—SECTIONAL VIEW CASKEY BLOW-OFF VALVE

water-tight contact is insured between the bushing and the plug by the use of a spring. This valve is the product of the Caskey Valve Co., Philadelphia, Pa.

A FINE RECORD FOR BELTS

SOME little time back, the Dixon Co. for the first time in 18 yr., took up a belt in one of its mill rooms.

For 18 yr. about 30 belts in that room have been run constantly; the belts are about 25 ft. in length and 6 in. in width. There is a great deal of graphite dust in the room, yet these belts have run satisfactorily without breakage or without being taken up for that period.

The belts are regularly treated with Dixon's Traction Belt Dressing, which comes in paste form, and a leather preservative as well as a belt dressing.

Of course, there are many who find it desirable or necessary to use a solid dressing, and for such Dixon's Solid Belt Dressing is suggested, but the Dixon Co. frankly states that some of the ingredients in the traction dressing cannot be reduced to solid form. If the solid dressing is preferred, one may use it with all safety, as a quick, sure cure for slipping belts.

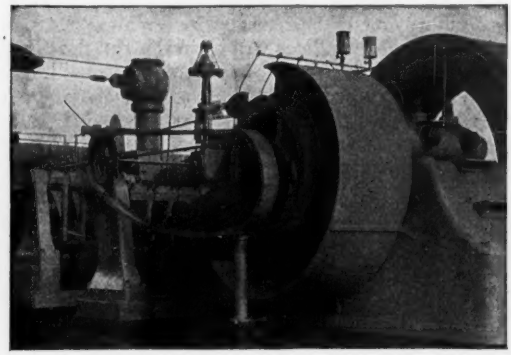
WITHOUT DOUBT, the greatest force to-day in the interest of confidence—credit if you will—is advertising.—Hugh Chalmers.

CHAIN GOVERNOR DRIVE FOR STEAM AND GAS ENGINES

BELTED drives on steam or gas engine governors are often a source of much trouble owing to stretch of the belting and the spattering of oil upon its surface. The belting requires close attention, for if belt slip is permitted, the engine becomes irregular.

The William Tod Company has for several years employed machine cut chain and sprocket governor drives as a means of overcoming these difficulties. The arrangement of sprockets, shafting and bevel gears by means of which an absolutely positive speed ratio is maintained between main and governor shafts is clearly shown in the illustration.

This particular drive is also interesting as a part of the largest tandem compound engine ever built (52



CHAIN GOVERNOR DRIVE EQUIPMENT ON LARGE COMPOUND ENGINE

and 90 by 60 in.). This engine was made to drive a 43-in. 3-high blooming mill in the Youngstown, Ohio, works of the Carnegie Steel Co. It is rated at 4,000 hp. but delivers a peak load of 5,000 hp., which is accomplished by means of a 24-ft. flywheel weighing 120 tons. The engine is, of course, dependent upon the governor for successful operation and the duty of the governor drive in steel mill work is unusually severe, owing to the sudden variation of load. Chain has proved to insure close governing and absolute dependability. In the illustration, the outboard bearing, flywheel, main shaft driving sprockets and the chains are removed to show the governing mechanism better. The position of the chains in service is indicated by that of the chain guard. It will be noticed from the double driven sprocket and the width of the chain guard that 2 chains are used.

These are of the standard roller type similar to the ones used in automobile service and are made by the Diamond Chain & Manufacturing Co., Indianapolis, Ind. A single chain transmits sufficient power to drive the governor shaft, but the second chain is added so that one chain will always be working in case of an accident to the other. The chains, however, have never given trouble from any cause, and they require no attention save an occasional oiling.

Machined chain has met with considerable favor in many places where belting has failed. In driving milling machine feed or parts of automatic machines where accurate timing is essential, chain is an excellent means of transmission. On slow and medium speed drives with short center distances, chain transmits practically all the power. There being no possibility of slip with chain it can be run without initial tension thus diminishing useless journal friction, the danger of hot boxes, the strain on shafting, and the amount of lubricants required.

CAREFUL BELT TREATMENT AS A GOOD INVESTMENT

ENGINEERS often pay little attention to their belting except that which is giving immediate trouble, when as a matter of fact, proper treatment with a suitable preservative at regular intervals would greatly benefit all the belting. Not only would the life of the belting itself be prolonged, but by increasing the pliability and lubrication of the internal fibers, the belting is kept softer and will cling to the pulleys better, so that it may be run slack without slip.

This alone insures a saving of power that would much more than pay for the attention and preservative preparation. Anybody will understand this on considering that the natural ingredients of a leather, cotton, or camel's hair belt or a manila or hemp driving rope, slowly dry out, leaving the contact surfaces too

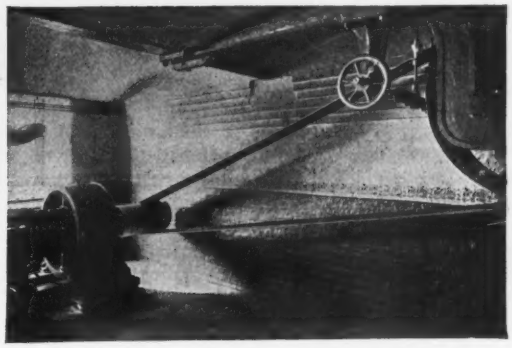


FIG. I.—UNTREATED BELT IN THE TOWNLEY MILL

hard to make close pulley contact. Unless something is added to replace these natural ingredients, the belt or rope cannot be expected to grip the pulley closely enough to transmit full load.

While the slip may be prevented by undue tightening, this is not the right method to make the belt do its full duty. The added tension cannot help but increase journal friction, strain the shafting, increase the danger of hot boxes and worn bearings and increase the number of delays due to sudden belt failures, the preventing of which alone effects great saving.

On the other hand, a belt that is kept clean, mellow and otherwise in good condition throughout, by means of a suitable preservative bends around the pulleys with less resistance and, by reason also of a closer conformity with unevenness of the pulley surface, can be eased or even run slack without danger of slip under full load. In fact a belt that is properly treated and is of correct dimensions for its work should break before slipping.

A practical example of the saving and satisfaction assured by proper care of belting is herewith illustrated by 2 photographs of a belt in the Townley Mill, Middleton, England. This belt, a 12-in. camel's hair, drives on the top half from a 4 ft. pulley (213 r. p. m.) to a 14-in. driven pulley and when the first picture was taken furnished power to a 628-light dynamo. Slip increased as the belt continued in service so that fre-

quently the belt had to be stretched to the tightness indicated in the first picture. In time, however, the belt manifested so great a tendency to fly off the driven pulley that a man had to be stationed where he could give it constant attention.

It was decided to experiment with belt preparations to improve the gripping power of the face of the belt, and Cling-Surface made by the Cling-Surface Co. of Buffalo, N. Y., was applied hot to its face and back by means of a brush. This preparation, it should be noted, is of such a nature that it permeates the belt completely and should be applied in thin coats at intervals so that it can soak in gradually and evenly. Successive applications were made which involved attention once a week or so until the belt was thoroughly saturated.

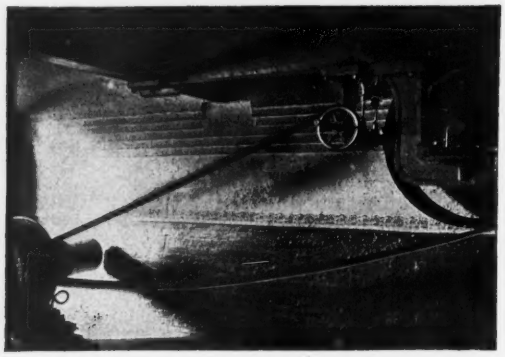


FIG. 2.—BELT TREATED WITH CLING-SURFACE

After the first few applications of Cling-Surface the trouble from slip disappeared and the belt was gradually eased until it ran slack as indicated in the second picture. The belt was first treated 3 yr. ago, and with a treatment of Cling-Surface every 2 or 3 months it gives no trouble now. Recently the enlargement of the plant necessitated increased lighting facilities. A new dynamo of 850 lights capacity replaced the old one, and although this was an increase of about 25 per cent, the old belt is still used and takes care of the larger load without slip or special attention.

WHAT IS PROBABLY THE OLDEST piece of wood in existence was found overlying the bed-rock at a depth of about 40 ft. below the street level, on the site of the United States Express Building, in Greenwich Street, New York, and was covered by a stratum of hard-pan about 11 ft. thick, above which was a layer of quicksand and muck about 30 ft. thick. The specimen of wood is slightly brown in color and is believed to have belonged to a now extinct species of cedar. As there was no way in which the wood could have been brought into this niche in the bed-rock after the hard-pan stratum had been deposited by the glaciers, it is evident that the tree of which this specimen formed a part had been growing before the glacial epoch.—Maurice Deutsch, in Harper's Weekly.

LET YOUR CUSTOMER KNOW that a personal interest attaches to him—a real personal interest that is not measured wholly by his orders and his dollar—and you will win in return that close, personal association and active support that builds up business.—George H. Barbour.

GET LEAVE TO WORK in this world; 'tis the best you get at all.—E. B. Browning.

NEWS NOTES

OFFICERS AND REPRESENTATIVES of the Harrisburg Foundry and Machine Works have been changed as follows: A. M. Morse, for many years in charge of the Chicago district has resigned and been succeeded by F. W. Jackson, formerly district manager at Baltimore. Mr. Jackson will have headquarters in the Marquette Building and Walter Bird will be associated with him as district engineer.

To succeed Mr. Jackson at Baltimore, C. H. Israel, formerly assistant engineer at the factory has been appointed and will have offices at 1415 Continental Trust Building.

In the St. Louis District, Geo. D. Pogue has resigned and Geo. M. Illges, until now in charge of the Atlanta office, will take his place. Headquarters will be at 1415 Chemical Building, with P. A. Haradon continuing as assistant engineer.

In Mr. Illges place at Atlanta will be R. B. Hall, Jr., who has previously been associated with Mr. Illges in that territory. His offices will be in the Empire Building.

For New Orleans, Walter Castanedo will succeed Glenny and Castanedo, and will have R. M. Doherty associated, as district engineer, with offices at 1103 Hennen Building.

ON THE 14TH OF APRIL, Buckeye Association, No. 38, N. A. S. E., of Columbus, Ohio, held an open meeting at which, after a number of speeches by local members, many of which contained bright hits which put all those in attendance in a good humor, an address was given by Royal Holbrook, of Dayton, Ohio, on "Boilers." A large number of visiting engineers was present from Dayton, Cincinnati and other Ohio cities, and some from New York City. Music was rendered through the evening by the Buckeye Republican Glee Club.

FOR THE V. D. ANDERSON CO. of Cleveland, O., a 70-hp. Bessemer gas engine has recently been installed with generator armature direct mounted on the shaft, to furnish light and power to the factory.

THE KERR TURBINE CO of Wellsville, N. Y., has arranged for representation in 2 more American and 3 foreign cities as follows: San Francisco and Oakland. Cal., United Iron Works; London, Eng., Economical Gas Appliance Construction Co., Ltd.; Mexico City, J. H. Bloomberg; Sidney, N. S. W., A. F. Partridge.

THE TECHNICAL PUBLICITY ASSOCIATION of New York held its regular meeting on the 10th of March, report of which is given in the April issue of the T. P. A. Bulletin. Discussion turned on the following up of inquiries from advertisements and also the second-class postage rate.

ON MAY 20 AND 21 the Illinois State Association of Engineers will hold its yearly convention at Moline, Ill., the headquarters being at the Manufacturers' Hotel and the convention hall and exhibits in the Knights of Pythias Hall, Skinner Building. Friday evening, May 20, will be devoted to an informal reception and registration at the headquarters; on Saturday the opening session will be held at 9 a. m., followed by a business session in the afternoon and a dinner and ball in the evening. Ladies in attendance will be taken on a visit to the government arsenal at 2 o'clock on Saturday afternoon. On the 22d visitors and delegates who can remain will attend church services in the morning and in the afternoon will be given a sightseeing trip by cars or steamboat. The hotel rates at headquarters will be $1, European plan. A large attendance is expected from all the associations in the state and a good time is assured.

THREE TURBINE BLOWING ENGINES have been ordered by the Iroquois Iron Co., Chicago, for the 2 new blast furnaces now under construction. This is the first large installation of turbine blast furnace engines in the United States. The engines are in 3 units, with the steam engine and turbine blower of each unit mounted on the same shaft. Each blower has a capacity of 40,000 cu. ft. a minute. The engines are of the Curtis horizontal condensing type and will be built at the Schenectady shops of the General Electric Co. The boilers are of the Russ Babcock & Wilcox type of 7,000 hp. capacity, using blast furnace gas. Hibben & Co., South Chicago, have been awarded the contract for the steel construction, amounting to about 3,000 tons. The ore bridges and bins will be built by the Brown Hoisting Machinery Co., Cleveland, Ohio. The ore bridge conveyors will be of 7½ tons capacity.

ON MARCH 31, Walter M. McFarland, who for 10 yr. has been vice-president of the Westinghouse Electric and Mfg. Co., became associated with the Babcock & Wilcox Co., at its offices in the Singer Building, New York. His notable work for 24 yr. in the United States Navy and for the 11 yr. since with the Westinghouse Co. are too well known to need comment. He has accomplished big things wherever he has gone and brings to his new work a long experience, and a winning personality which have made countless friends.

STATE CONVENTIONS of engineers will soon be in full swing. In May the Iowa fellows will meet at Waterloo the 5th to 7th, and those of Illinois will meet at Moline on the 20th and 21st.

June is the busy month; on the 3d and 4th the Pennsylvania state boys will gather at Scranton, and the New Jersey association follows close, on the 4th and 5th, at Jersey City.

From the 6th to the 10th the American Order of Stationary Engineers holds its national convention at Philadelphia.

The 10th and 11th New York at Buffalo, and Kentucky at Hopkinsville will be in session.

Then a breath until the 17th and 18th, when the Wisconsin boys meet at Oshkosh, and the next week both Ohio and Connecticut are in session, Ohio from the 23d to the 25th, at Hamilton, and Connecticut, the 24th and 25th, at New Haven.

So far only 2 meetings are reported for July; Massachusetts, the 7th to 9th, at Lowell, and Michigan, the 21st to 23d, at Kalamazoo.

And every convention will be well worth while and of the greatest good to those who attend and the profession at large.

AT THE SECOND ANNUAL DINNER of the Modern Science Club of Brooklyn, the speakers were Wm. G. Freer, vice-president; Wm. Smith, past president; F. L. Johnson, of New York; Edwin P. Moritz, of Atlanta; Herbert E. Stone, of Boston; Wm. T. Wheeler, of New York; John H. Foote, of Troy, and Wilson Van Buren, of New York. James A. Donnelly, secretary, acted as toastmaster. Other officers of the club are Frank J. Wood, president; George O. Kaley, treasurer.

GEO. H. THACHER & CO., of Albany, N. Y., which has been a partnership since 1852, has recently incorporated with a capital stock of $400,000, to do a general casting business in gray iron, brass and grate bars, including the manufacture under the patents of C. T. Coe of the Coe Sectional Shaking Grate and the Coe Improved Combustion and Draft System. Extensive alterations and improvements of the plant are under way which will enable the company to double the present output.

THE FOREST SERVICE OF THE Department of Agriculture will hold on May 4 examination in the principal cities of the country for Laboratory Aid and Engineer to be employed in the Forest Products Laboratory at Madison, Wis., at a salary of $900 a year. The examination will consist of arithmetic, on the fundamental rules of addition, subtraction, multiplication, division; the operation and care of boilers and steam pumps, while training and experience will be counted as 60 per cent on the examination. Experience is desired in the installation and operation of wood preservation, pulp mill, wood-working or timber testing machinery, the installing of plumbing, piping and steam fitting and acquaintance with the properties of American woods. Men who are able to assist in the handling of pipe fitting and setting up of machinery, 18 yr. of age, or over, will be eligible. Further particulars can be had by applying to the United States Civil Service Commission, Washington, D. C., for application form No. 1312.

FROM THE BOARD OF BOILER RULES of good old Massachusetts comes a most valuable set of Tables of Boiler Joint Strengths and Efficiencies. These tables were computed by W. W. Ramsay, state inspector of boilers, and cover double riveted, triple riveted and quadruple riveted butt strap joints for plate from ⅜ in. to 1 in. thick. It is the most complete table that has ever been prepared on this subject and of the greatest importance to all who have to deal with construction or operation of boilers.

MASSACHUSETTS STATE ASSOCIATION, N. A. S. E. will hold its convention in Lowell, July 7, 8 and 9. Lowell is a manufacturing city of over 100,000 inhabitants and the center for the purchase of supplies for a large outlying territory. Prescott Hall, a large hall in the business center of the city, has been secured for space for those desiring to exhibit steam specialties and power plant necessities. Booths will be erected, the exhibition well advertised and every facility offered to make this feature of the convention a great success. The convention meetings will be held in the same building, thus making a compact lay out and, one that will insure a large attendance at the exhibit. The exhibition will open at noon on the 7th and continue through the 7th and 8th. The business session of the convention will be held on the 8th. The 9th will be taken up in sightseeing and a general good time, at one of the nearby resorts. Those desiring to avail themselves of the opportunity of making an exhibit, should notify the secretary, Joseph Collins, 10 Varney St., Lowell, Mass., as soon as possible, that suitable arrangements may be made for them.

FRANK W. A. CAMPBELL has severed his connections with the General Electric Co. and has opened an office in Houston, Tex., for consulting and constructing engineering along electrical lines. For the past 5 years Mr. Campbell has been in the construction department of the General Electric Co., coming from the Schenectady works to the Chicago office. During that time he has installed a large variety of apparatus, especially that which pertains to central stations, heavy electric traction and industrial plants. He will have a force of expert mechanics, 2 of whom have been on foreign construction for the General Electric Co.

CLEMENT RESTEIN CO. of Philadelphia,, which manufactures Belmont packings, has opened a branch office and stock room at 11 Woodward Ave., Detroit, Mich., with E. N. Marcy, formerly at the Restein general office, as manager in charge.

IN THE FIELD of Engineering and Equipment the entrance of a new firm whose members bring to their work 16 years of experience with large machinery houses will be of interest to those in the market. The Reliance Engineering and Equipment Co. of Milwaukee, Wis., has

been formed for supplying material, machinery and equipment and C. A. Tupper, at present of the Allis-Chalmers Co., is the manager. Only the best apparatus will be handled as Mr. Tupper will maintain in the new business the high standards that he has always set for himself and others. The Milwaukee offices will be at 330 Clinton St., and the office in San Francisco at 604 Mission St.

BENJAMIN K. HOUGH has been appointed Boston sales manager for the Wisconsin Engine Co. and will have offices in the Oliver Building, Boston, Mass.

THIS YEAR 1300 students are enrolled in the College of Engineering of the University of Illinois, of which number approximately 160 will graduate early in June. Those who are to graduate will be looking for permanent employment, and those who are members of the lower classes should look forward to active work during the 3 months of the summer vacation.

Among the men who will be available are representatives of all the different fields of engineering, such as civil, electrical, mechanical, municipal and sanitary, and railway; also of architecture, architectural engineering and architectural decoration.

The graduates who will be available for permanent positions are ordinarily from 21 to 24 years of age. They are not boys, but men. In their career as students they have been subject to a severe winnowing process. Those who have survived may generally be depended upon as having sound bodies, good habits, and fairly well-trained minds. They constitute promising material for beginning positions.

The undergraduates who are in need of work during the summer vacation are commonly available for service from the middle of June to the middle of September. They are from 19 to 22 years of age. They want a chance to work, in the expectation of earning what they receive. Some of them are capable of giving excellent service in the shop and factory, and others can do good work in the drafting room, in the field, or in the office.

Those who may be interested in employing college men, if they will send to Dean of the College of Engineering W. F. M. Goss, a statement of their needs, will be put in communication with acceptable men.

THE TENTH ANNUAL SESSION of the Summer Schools for Engineers and Artisans, under direction of the College of Engineering of the University of Wisconsin opens June 27th, continuing for 6 weeks.

Advanced courses are offered in Direct and Alternating Currents, Hydraulics, Machine Design, Descriptive Geometry, Applied Mechanics, Shopwork, Steam and Gas Engineering and Surveying. Elementary courses for artisans, and those not having preparation for the advanced work, are offered in Applied Electricity, Engines and Boilers, Fuels and Lubricants, Mechanical Drawing, Machine Design, Materials of Construction, Shopwork and Surveying.

The teaching staff is taken from the regular instructional force, and all laboratory equipment of the engineering college is available for students. For bulletin or further information address P. E. Turneaure, Dean, College of Engineering, Madison, Wisconsin.

PAUL T. PAYNE, who has had charge, temporarily, of the Philadelphia office of the Dearborn Drug & Chemical Works, for the past 2 yr., has returned to Chicago to do special work, out of the general offices. Mr. Payne has been connected with the Dearborn Co. for the past 12 yr., having spent a number of years in its laboratory, before entering the sales department. Mr. Payne's assistant at Philadelphia, P. G. Jones, will assume the management of the Philadelphia office, covering eastern Pennsylvania, and W. J. Stokes will look after the Dearborn Co.'s interests in Maryland and Virginia, with office at 809 American Bldg., Baltimore, Md. Mr. Stokes was formerly with the H. W. Johns-Manville Co. Both Mr. Jones and Mr. Stokes will work under the general supervision of the New York office of the Dearborn Drug & Chemical Works, at 299 Broadway, the headquarters of Grant W. Spear, vice president and general eastern manager.

PHILIP B. WOODWORTH, dean and professor of electrical engineering at Lewis Institute, Chicago, has become associated as consulting expert on electrical inventions and patent suits with Rummler & Rummler of Chicago.

THE OHIO SOCIETY OF MECHANICAL, Electrical and Steam Engineers will hold its 21st meeting at Cincinnati, O., in the convention hall, Sinton Hotel, May 19-21. On the 19th visits will be made to the plant of the Lunkenheimer Co. and the Union Gas & Electric Co., and in the evening papers will be read on Selecting a Boiler, by F. C. Bitgood, of the Babcock & Wilcox Co., and Scientific Treatment of Boiler Feed Water, by Herbert E. Stone, of the Dearborn Drug & Chemical Works. Friday morning will be given to a business session and to papers on Refrigerating Machinery and Appliances, by H. D. Pownall, of the Triumph Ice Machine Co., and Metallurgical Considerations in the Manufacture of High-Pressure Valves and Fittings, by Geo. K. Elliott, of the Lunkenheimer Co. The afternoon will be devoted to inspection trips to the plant of the Triumph Electric Co. at Oakley, and the Philip Carey Co. at Lockland. The evening session will take up papers on Centrifugal Pumps, by L. G. Finlay, and on the Kinney Positive Pressure Rotary Pump, by C. O. Thurston.

KEYSTONE LUBRICATING CO. has moved its Chicago Branch Office from the Tacoma Building to 2123 Michigan Ave., where more room and increased facilities are provided for handling Keystone Grease.

BOOK REVIEW

TESTS OF TUNGSTEN LAMPS, by T. H. Amrine and A. Guell, issued as Bulletin No. 33 of the Engineering Experiment Station of the University of Illinois, is a report of a series of tests upon tungsten lamps of the 25-watt size, having filaments made by the paste, colloid and deposition processes, and mounted according to different methods. The tests show what may be expected of the low wattage tungsten lamps now on the market, in the way of life, maintenance of candlepower and efficiency, under both good and poor conditions of operation, as regards voltage, fluctuation and vibration. The great influence of the mode of mounting the filaments upon the life of the lamps, when subject to vibration, is made evident. Curves are presented showing the progress of bulb discoloration for each of the three types of lamps. Copies of this bulletin may be obtained gratis upon application to W. F. M. Goss, director of the Engineering Experiment Station, University of Illinois, Urbana, Ill.

THE INDICATOR HAND BOOK, by Chas. N. Pickworth. 130 pages, illustrated, 5 by 7 in., cloth binding. New York, 1909.

This work, by an English author, is designed to be a manual for engineers on the practical use of the indicator. It deals with the method of constructing adiabatic and hyperbolic curves and gives a convenient table for such work, showing the pressure at different points during the expansion. The diagram in detail is then considered, showing the correct form of the different parts and the various faults which may occur, and explaining what is likely to cause these faults. From this one naturally goes to the analysis of a diagram as taken, to see what

it indicates as to setting of valves, leakage of valves or piston rings, and distribution of load on the engine. Diagrams from compound engines are analyzed and the method of combining these to show the complete expansion is shown. Gas and oil engines come in for a chapter, also air compressors and pumps, the final chapter being devoted to calculation of the power of an engine from the diagram and the use of the planimeter. Tables of areas of circles and properties of saturated steam are given at the end of the book. It will be found useful by all who are not entirely familiar with what the indicator diagram can teach us as to the action of an engine.

GAS ENGINE THEORY AND DESIGN, by A. C. Mehrtens. 256 pages, illustrated, 6 by 8 in., cloth bound, New York, 1909. Price, $2.50.

A book for those interested in gas engines as students, designers or operators, intended to show the why of things as well as the how. A chapter on history shows the development from the beginnings, and a chapter on applications shows the present status of the art.

Three chapters are given to the theoretical side of heat, combustion, fuels and efficiency. Then follow treatments of explosive mixtures, mixing valves, governing, ignition, cooling, exhaust and the selection of type, all these being briefly treated from the standpoint of the practical operating man. The rest of the book is given to design and testing, showing designs of detail parts, the methods by which the dimensions are worked out, and the method of conducting a test to get the power developed and find where the different losses occur. In the appendix are given a number of reports of tests showing what may be expected in the performance of well designed plants.

ACCOUNTING EVERY BUSINESS MAN SHOULD KNOW, by E. E. Garrison. 188 pages, 5 by 7 in., New York, 1909. Cloth bound, published by Doubleday, Page & Co.

This is one of the different kind of books. It does not attempt to make an expert bookkeeper of the reader, nor to deal with the intricate details of large accounting systems, but it does attempt to bring to the man who is not familiar with accounting, its objects and its methods, a clear idea of why accounts are valuable, how a system should be devised, what it ought to show and how it can be made to show it. And to a reader who will give the book his attention the author has succeeded in bringing this result. It is accomplished by showing the origin of accounts and how the simple memoranda which would naturally be kept by anyone making credit sales have developed into the modern accounting system with its great mass of information for the manager of a business; and it should be remembered that correct accounting is necessary not only in the financial management of a business but in the operating management as well, for accounts should tell us not only how much we have spent and how much we have taken in, but what each department of an organization has cost us and what the return has been from that department in the shape of kilowatt-hours, or manufactured goods, of sales made, or of money received. The author brings to his work 20 yr. of experience and has used it for the benefit of his readers.

THE WEATHERING OF COAL, by S. W. Parr and W. F. Wheeler, issued as Bulletin No. 38 of the Engineering Experiment Station of the University of Illinois, reports a continuation of the experiments of the weathering of coal published under the same title in 1907 in Bulletin No. 17. The experiments described in the present bulletin deal with car-load lots of coal under conditions comparable with actual experience in the storage of coal. Car-load lots of both nut and screenings were exposed in covered bins, in open bins, and under water, for a period of one year. The initial values were determined for the freshly-mined coal, and analyses were made approximately after two days, ten days, two months, six months, and one year.

In general, the conclusions are that coal of the type found in Illinois and neighboring states is not affected seriously during storage when only the changes in weight and losses in heating value are considered. The losses due to disintegration of the coal and to spontaneous ignition seem to be of far greater importance than any changes in weight or heating value, although they cannot be expressed in figures for comparison. Aside from certain advantages in favor of storing coal under water, there seems to be very little to be said in favor of any particular method of storing coal.

Copies of Bulletin No. 38 may be obtained gratis on application to W. F. M. Goss, director of the Engineering Experiment Station, Urbana, Ill.

CATALOGS

FOR BLOWING FORGES a new set is now marketed by the B. F. Sturtevant Co. of Hyde Park, Mass., consisting of motor and direct connected multivane fan. It is designed for use with 1 or 2 forges and has, of course, many advantages over the use of a large blower serving several forges. The blast can be quickly varied to meet the requirements and the greatest economy of power secured. A new bulletin, No. 177, gives details and price.

EXTENSIVE USE OF ROTARY CONVERTERS, particularly in connection with electric lighting and industrial power plants, frequently necessitates a variable ratio between the alternating and direct-current voltages for charging storage batteries and compensating for line drop as well as for numerous other special requirements. To simplify the wiring arrangements and reduce the cost of auxiliary devices, the General Electric Co. has developed a line of regulating pole rotary converters, which are adapted for a variety of purposes where a variable conversion ratio is required either to maintain constant direct-current voltage with varying alternating-current voltage, or to vary the direct-current voltage as required. They are built in capacities of from 300 to 3,000 kw., with a voltage range between 240 and 300, to cover the usual lighting circuit requirements. Bulletin No. 4723, just issued by the General Electric Co., describes and illustrates this line of converters.

Another attractive publication recently issued by this company is entitled "Transformer Manufacturing Facilities," describing the facilities for the production of transformers at the Pittsfield Works of the company, which now constitute one of the largest and best equipped transformer manufacturing plants in the world. This pamphlet illustrates various processes of transformer manufacture, and is sure to be of interest to all whose business is connected with electrical work; it is booklet No. 3919.

GENUINE DETROIT LUBRICATORS as made by the Detroit Lubricator Co. is the subject of an interesting catalog which describes sight feed and plain cylinder lubricators with all the original Detroit features. Cross sectional views showing the construction of the different types and explanations of how they operate are special features.

RIDGWAY DYNAMO & ENGINE CO., of Ridgway, Pa., in its 2 recent bulletins, Nos. 23 and 24, describes first the Ridgway adjustable cutoff engines, showing how they operate and the effect of the variable cut-

off on the diagram, and second the alternating-current generators which this company makes, giving detailed description of the construction with illustrations of the different parts. These bulletins can be had if you send for them.

"THE LITTLE BIG ENGINE" story is published in a series of chapters, each one forming a special bulletin, by the Elyria Gas Power Co., of Elyria, O. Each one is an important part of the story, and the whole series completes the interesting tale of what gas power is and what it does.

AN IMPROVEMENT FOR EXHAUST STEAM HEATING SYSTEMS is described in a small booklet published by the Harrison Safety Boiler Works, 3144 N. 17th St., Philadelphia, Pa., consists of the new Steam-Stack and Cut-Out Valve Heater and Receiver, recently introduced by that concern. It is claimed that the use of this heater will reduce the expense of equipping any system of exhaust steam heating, by saving the cost of an independent separator in a by-pass around the heater to the heating system, and the cost of the trap, valves, fittings, etc., required for its installation. Several different types of the new heater are illustrated, some adapted for the very limited headroom of basement boiler rooms.

GREENE TWEED & CO., 109 Duane St., New York, in a folder just issued, shows a handsome line of brass specialties, including door pulls, coat and hat hooks, cupboard locks, refrigerator hinges and clasps, and catch bolts.

ALLIS-CHALMERS CO.'S latest bulletin No. 1618, entitled "Fighting Fires with High Pressure Streams," represents a recapitulation of reports of the most notable fires on Manhattan Island occurring within the past year, at which the direct high pressure system was used. Allis-Chalmers Co. furnished the pumping units for this installation; and, in accordance with specifications, they were submitted to an endurance test for the purpose of determining their capacity and efficiency. This test was conducted by Prof. R. C. Carpenter of Cornell University, and his report is also printed in this bulletin. It was found that the capacities of the pumps were from 15 to 20 per cent in excess of that specified, and efficiencies 2 per cent greater than guaranteed by the builder. A copy of this bulletin can be had upon application to the company's department of publicity, Milwaukee, Wis.

CROSBY STEAM GAGE & VALVE CO. is distributing a neat folder containing 9 handsome plates which describe the various forms of Crosby indicators for steam and gas engines, ammonia and air compressors, hydraulic pressure and the like.

UNIT COAL and the Composition of Coal Ash, by S. W. Parr and W. F. Wheeler, is issued by the Engineering Experiment Station as Bulletin No. 37. This is a report of a series of experiments on coal, together with a tabulation of calculated values for unit coal for Illinois, Ohio, and other coal regions of the United States. The results show great constancy in the value of unit coal for any given mine or region, notwithstanding the fact that the value of the natural coal as mined may vary between wide limits. Copies of Bulletin No. 37 may be obtained on application to W. F. M. Goss, University of Illinois, Urbana, Ill.

THE WEINLAND QUICK REPAIR HEAD is the title of a little booklet recently published by the Lagonda Manufacturing Co., of Springfield, Ohio. This booklet is devoted mainly to a discussion of the merits of the new Weinland Head which the company has recently brought out, and shows how the head can be quickly taken apart and new sharp cutter wheels installed. This booklet, which is gotten up in pocket size, also gives a brief description of the various other appliances built by the Lagonda Mfg. Co.

STANDARD ELECTRIC TIME SYSTEMS include master clocks, secondary clocks, bell signals, program clocks, time registers and time stamps. All are described and illustrated in Catalog No. 32 of the Standard Electric Time Co., of Waterbury, Conn., making this a complete treatise on time systems and apparatus.

GRAPHOIL, a convenient pocket booklet issued by the Graphoil Lubricator Sales Co., of New York City, tells about a number of interesting specialties for the feeding of graphite with oil to steam cylinders of engines, locomotives, pumps and the cylinders of gas engines, air compressors and other places where continuous lubrication is needed. The book also gives information as to the savings to be effected by this method of lubrication.

THE GENERAL ELECTRIC CO. has just issued the following bulletins, which describe apparatuses of its manufacture that have recently undergone improvement in design:

Bulletin No. 4719 illustrates and describes fans suitable for use in the home, office, or public building, for installation on a desk, table, wall, floor or ceiling, and for use in telephone booths. It lists also fans for ventilating purposes, and illustrates small power motors for both domestic and commercial use.

In Bulletin No. 4721 are illustrated and described to some extent the company's direct current watthour meters. Types C-6, C-7 and CQ. These meters are so constructed as to be easily and quickly installed and sealed. They are substantially made and the entire mechanism is assembled upon a skeleton casting, which in turn is fastened within the meter casing.

Bulletin No. 4720 describes in considerable detail the company's steam and air flow meters. The economical generation or consumption of steam, like that of electricity, gas and other commodities, depends on accurate information which will show the amount being generated, consumed or distributed. Equally important is the determination of the exact amount of air being delivered or consumed, where air is used in place of steam as a working agent.

The relative merits of the ordinary electric meter and that of the prepayment type have been thoroughly established. Each meter has its own field. In Bulletin No. 4716 are described several types of prepayment watthour meters, which form a practical solution of the problem of producing a satisfactory prepayment meter having a minimum number of complicated parts, and sufficiently strong to withstand the rough treatment incident to transportation and commercial use. These meters are arranged for use with either a separate or combined prepayment device.

Bulletin No. 4717 is devoted to the use of the flame arc lamp, for the lighting of streets and large interiors. The high efficiency of the flame arc lamp is well known. The descriptions of various lamps are taken up in detail and will prove of interest to central station men.

The rapid increase in the use of concrete has necessitated a corresponding increase in the manufacture of Portland cement. Bulletin No. 4722 enters more or less into the details of electric drive in connection with the manufacture of this material, pointing out the ad-

vantages, offering suggestions to mill owners, and illustrating a number of installations.

"THE ANGLER" comes to hand as a bright little monthly from the Nason Mfg. Co. of New York City. Every page is useful and the small amount of attention which the company asks for its product in no wise detracts from the main purpose. It will be mailed regularly to engineers on request.

CENTRIFUGAL PUMPING MACHINERY is built by the Morris Machine Works, of Baldwinsville, N. Y., and the different types are listed and described is an attractive catalog which bears that name. There's a lot of good data about these pumps, sizes, capacities and how they work.

THE HAYS SCHOOL OF ENGINEERING, of Rogers Park, Chicago, Ill., has prepared an interesting and thorough course on fuel and combustion engineering, intended to be taught by correspondence. It consists of a series of 12 lessons, each bound in pamphlet form, convenient pocket size, and takes up the principles of chemistry, coal and its chemistry, the application of chemistry to combustion, the smoke problem, gas producers and engines, furnace types and construction, and how to stop fuel waste. On each lesson there is a full set of questions, which bring forcibly to the attention of the reader the important points to be remembered.

THE SMOKE ABATER CO., of Providence, R. I., is placing on the market the American Automatic Damper, which supplies air in proper quantity at the time of firing coal, and gradually decreases the air supply as the fresh coal becomes partially burned. It thus improves combustion, helps keep surfaces clean and allows of using cheaper coal. The method of working of the device is interestingly described in a well designed and printed booklet, which has just reached us and can be had on application to the company.

"STEAM AND POWER PUMPING MACHINERY" as made by the American Steam Pump Co., of Battle Creek, Mich., covers the complete line of Marsh and American Pumps. It is necessary to see the handsome catalog of these pumps, which has just been issued, in order to really appreciate the book. It is full of useful information, printed in attractive style with illuminated page heads on a heavy enameled paper stock, with a heavy, beautifully designed art cover. The tables of proper sizes and capacities, requirements for fire service, and other hydraulic data, make the book most desirable as an addition to the engineer's collection.

THE BAILEY COMBINATION sheet and pair furnace is for the use of steel works, and in the catalog which describes it, as sent out by Geo. J. Hagan, of Pittsburg, an interesting feature is the Underfeed Stoker attachment for supplying fuel to the furnace. This is the same type of stoker as applied for boiler feeding, and operates in the same way.

VULCAN MECHANICAL FUEL FEEDERS, made by the Vulcan Furnace Co., of Buffalo, N. Y., are an interesting addition to the methods of supplying fuel to a boiler. The Vulcan Feeder is intended for attachment in place of the ordinary firing door, and may be supplied with coal either by hand, or by conveyor system.

The method of feeding the coal as well as the construction of the feeder are fully shown and described in the catalog of the Vulcan Furnace Co., which is available on application to that company.

THE SERVICE PUMP made by the Orville Pump and Furnace Co., Orville, Ohio, is a new idea in pump construction. Special features of this pump are described in the catalog issued by the company, which will be sent to those interested upon application.

TRADE NOTES

ALLIS-CHALMERS CO. reports that its gas engine business continues to increase and at present the full capacity of the gas engine shop is required for gas engines alone. Some of the recent sales are 2 18 by 24-in. engines with generators to the Ware County (Ga) Light and Power Co.; 1 18 by 24-in. engine and generator to the American Car and Foundry Co. for its plant at Huntington, W. Va.; 3 24 by 36-in. engines and generators to the Alpha Portland Cement Co. for its new plant at Alsens, N. Y., and 3 18 by 24-in. engines and generators to the Guanica Centrale Co. for a sugar mill in Porto Rico. There are many other propositions under consideration and it is apparent that the gas engine is now fully as acceptable for power purposes as any other type of prime mover.

THE BROWN & SHARPE MFG. CO., of Providence, R. I., has just purchased 6 more Taylor Gravity Underfeed Stokers from the American Ship Windlass Co., Providence, R. I. These stokers, each having 2 retorts, are to be used under B. & W. boilers, Stirling type. This order for Taylor stokers is the second received from the Brown & Sharpe Mfg. Co., in whose plant 400 hp. of boilers were equipped with this type of stoker.

CHANDLER-BOYD SUPPLY CO. announces the commencement of its general Mill Supply business on Apr. 15, 1910, at the Terminal Warehouses, Pittsburgh, Pa., with a complete stock of iron and brass pipe fittings and valves, wrought-iron pipe and steam specialties. This company acts as special jobbers of the Pittsburgh Valve & Fittings Co.'s goods in the Pittsburgh District, and will carry in stock a large and varied assortment of the celebrated "P" fittings for immediate shipment at all times, comprising standard and extra heavy cast-iron screwed and flanged fittings; black and galvanized malleable iron fittings; the genuine Pittsburgh Iron Body Gate Valve, made screwed and flanged in both standard and extra heavy weights; iron and brass globe, angle, check and cross valves; brass and iron cocks, screwed and flanged; regrinding globe, angle, check and cross valves; blowoff valves; steam traps; expansion joints, etc., etc.

THE FOLLOWING LETTER to the Jacobson Engine Co. shows clearly why the gas engines manufactured by this company have become so popular in the power plant field: "It gives me pleasure to be able to state that the 120-hp. Jacobson Automatic Twin Cylinder suction producer gas engine in my charge at C. E. Hertlein's silk mill, in New York, is giving very good satisfaction. It is running 10.25 hr. every working day without the least trouble, doing from 90 hp. to 100 hp., with an average coal consumption of about 1200 lb., including all standby losses. This is a saving of over 1¾ tons of coal per day as compared to our use when operating our Corliss engine at about 60 hp. The difference in power is due to the electric lighting load when the gas engine is used. I consider that with good care we have less trouble with our Jacobson engine than with a first-class steam plant. To anyone interested in gas power plants I am pleased to show and explain this engine." —John Auth, Chief Engineer.

PRACTICAL ENGINEER CLASSIFIED ADVERTISEMENTS

Advertisements in this section are inserted under regular headings at the rates of 40 cents per line. About nine words make a line. No display type is allowed, but the first three words may be set in capital letters. Minimum space sold, two lines.

Under classification, "Positions Wanted," advertisements not exceeding four lines will be inserted for subscribers once free of charge.

To insure proper classification, copy must reach this office on or before the 15th of month preceding publication.

Positions Wanted

EXPERT CORLISS ENGINEER desires to make change in position. At present operating 3-phase plant; age 42; married; twenty years' experience. A1 references. Address Engineer, Box 131, 4520a Rutger St., St. Louis, Mo.

POSITION WANTED—By a young engineer, 32 years of age, as chief engineer in a large power plant or in a cold storage plant. Can handle all kinds of machinery. Best of references. Address Box 132, Practical Engineer. 4-1

POSITION WANTED—High grade salesman, age 35, desires change; experienced in steel, power machinery and heavy lines, with record proving ability to close large sales; confidential correspondence invited. Address S. S., Practical Engineer. 4-2

POSITION WANTED—By engineer with four years' experience in running Corliss engines; experienced with kerosene and gasoline engines, also dynamos. At present in charge of a plant but desires a change; West preferred. Address Box 133, Practical Engineer. 5-1

POSITION WANTED—By engineer and electrician holding first-class Ohio license, as chief engineer or to take charge of plant. Understand thoroughly all modern appliances for economical power production and can assure results. Ten years experience with high speed Automatic and Corliss engines, A. C. and D. C. generators, air compressors, water and fire tube boilers and several makes of stokers. At liberty about June 1st. Address Box 131, Practical Engineer. 5-1

Help Wanted

AGENTS WANTED to sell Burgmann celebrated engine packings in territories not yet covered. See our advertisement on page 14 of this issue.

WANTED—AN ENGINEER in each town to sell the best metallic packing for steam, air, gas and ammonia. Write Ideal Metallic Packing Co., South Stillwater, Minn. 5-tf

WANTED—ENGINEER in every town or city. You send us the names, we sell the goods and pay you the commissions. Write for particulars. The Lloyd Mfg. Co., Menominee, Mich. 5-1

AGENTS WANTED—West of Buffalo and Pittsburg to sell a necessary power plant specialty that is a big money maker. We allow a liberal commission. Address, stating experience, Box 126, Practical Engineer. 3-tf

SALESMEN IN EVERY LOCALITY, who are now calling on power plant trade, to handle as side line on commission two high grade, established specialties. For full particulars address W. T. Jameson, 100 Surrey Rd., Mansfield, O. 4-2

SALESMAN WANTED—To interview the voters in each county on a new proposition. The (1910) census one of the features; excellent remuneration; exclusive territory; training given. Address Rand, McNally & Co., Chicago, Ill. 4-2

WANTED—OPERATING ENGINEER in large street railway power house. Good position and steady employment to right man. State experience, age, married or single and former employment. Address Armstrong News Co., 419 Main St., Cincinnati, Ohio. 5-1

WANTED—A hustling general superintendent for a small electrical plant manufacturing electric vacuum cleaners. A good salary and an excellent opportunity for advancement is offered to a competent general superintendent. Must be a hustler, able to get work through the shop and a good organizer. Address Box 130, Practical Engineer. 5-2

ENGINEERS AND MECHANICS—To make big money selling Incomparable "ZIZ" Hand Soap. A 10-cent can will instantly remove more dirt and stains from the hands than four cakes of any soap made, and it will not injure the most delicate skin. Small sample free. Byram Mfg. Co., Box 3133, Boston, Mass. 4-tf

WANTED—Established and experienced engineering specialty salesman to sell, on commission basis, to power plants and jobbers in exclusive territory, the most widely advertised specialty of its kind; used by everp power plant in the country. We have a particularly attractive proposition. State Experience. George M. Newhall Engineering Co., Philadelphia, Pa. 4-4

AGENTS WANTED to represent us in the sale of Cassco Bar and Ring Metallic Packing—a metallic packing which costs about the same as soft packing and will wear from seven to ten years. Can be handled as a side line very acceptably. Some territory still open for steam specialty men to handle the Erwood Positive Duplex Blow-off Valve and the Erwood Reversing Automatic Non-Return Valve. Address Triumph Engineering & Supply Co., 253 La Salle St., Chicago, Ill. tf

For Sale

FOR SALE CHEAP—Belt-driven air compressor, side valve engine and two boilers. National Can Co., Detroit, Mich. 4-3

FOR SALE—Patent No. 897285, an entire metallic automatic return valve for use in connection with vacuum heating system. No carbon or rubber cores, no springs, no floats. Perfect operation from 150-pound steam pressure to under any degree of vacuum. Also patent No. 791773 on the "Greenaway" cast iron exhaust head, the original cast iron exhaust head; over 1,000 in successful operation. Both these patents will be disposed of at a low figure to the right party. Address A. J. Greenaway, 1206 Chamber of Commerce, Detroit, Mich. 4-2

Patents and Patent Attorneys

PATENTS—Watson E. Coleman, Patent Attorney, Washington, D. C. Advice and books free. Highest references. Best services. 4-tf

FREE BOOKLET—All about patents and their cost. Shepherd & Campbell, Patent Attorneys, 500 M. Victor Bldg., Washington, D. C. 5-tf

PATENTS OBTAINED AND TRADEMARKS Registered—Our booklet, "Concerning Patents," mailed free. Calver & Calver, Patent Attorneys, Washington, D. C. (Formerly Examiners, U. S. Patent Office.) 3-2

DIETERICH'S 50 PERPETUAL MOTIONS—100 mechanical movements; books tell about perpetual motion and how to obtain patents; by mail for 25 cents, postage or coin. F. Dieterich & Co., Patent Lawyers, 64 Oray Block, Washington, D. C. 4-tf

PATENTS—C. L. Parker, late Examiner U. S. Patent Office, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. 186 McGill Building, Washington, D. C. 4-tf

Educational and Instruction

MECHANICAL DRAWING—Ten lessons one dollar. Additional lessons ten cents. Lucian Jones, 115 South 54th St., Philadelphia. 3-2

Miscellaneous

GREASE, OIL AND LUBRICATE your loose pulleys and shafting with graphite, mica or asbestos candles; no drip; no dirt; economical. Swain Lubricator Company, 250 Lake St., Chicago. 5-6

WE WILL GIVE FREE of charge to one firm manager or engineer in each town, a well-known indicator and Reducing Wheel, with a trial order for our dry block or powdered compound; satisfactory results first and then pay. Great Lakes Chemical Co., Manitowoc, Wis. 4-2

ARE YOU LOOKING FOR new lines to keep your shop profitably employed? A holding company will lease right to manufacture and sell high and low pressure reducing valves. A square deal in control and royalty. If you're a good salesman and have reputation, credit and confidence in yourself, this is a worth while opportunity. Address W. V., care Practical Engineer, Chicago. 4-2